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**Conference of the Parties to the
Minamata Convention on Mercury
Second meeting**
Geneva, 19–23 November 2018
Item 5 (f) of the provisional agenda*

**Matters for consideration or action by the
Conference of the Parties: capacity-building,
technical assistance and technology transfer**

Compilation of submissions and reports received in relation to alternative technologies and technology transfer as referred to in paragraph 4 of article 14

Note by the secretariat

As referred to in the note by the secretariat on the matter (UNEP/MC/COP.2/10), a compilation of submissions and reports from parties and other stakeholders on issues relating to existing initiatives and progress made in relation to alternative technologies; on the needs of parties, particularly developing-country parties, for alternative technologies; and on challenges experienced by parties, particularly developing-country parties, in technology transfer, is set out in the annex to the present note. The submissions and reports are reproduced as received, without formal editing.

* UNEP/MC/COP.2/1.

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Annex

Compilation of submissions and reports received in relation to alternative technologies and technology transfer as referred to in paragraph 4 of article 14

I. Information submitted by Japan

Information from Japan upon the Request from the Minamata Convention Secretariat on Capacity Building, technical assistance and technology transfer on the Minamata Convention on Mercury

June 2018

At the Diplomatic Conference of the Minamata Convention on Mercury, Japan expressed its intention to support developing countries and promote voices and messages from Minamata, through the actions titled "MOYAI Initiative." As part of this initiative, the MINAS (MOYAI Initiative for Networking, Assessment and Strengthening) is being promoted. MINAS is a program of Ministry of the Environment, Japan that is designed to support developing countries' efforts in mercury management by providing measures including the various activities with close cooperation and collaboration with relevant agencies.

1. Information relating to Paragraph 4 and 5, Article 14 of the Minamata Convention

The Paragraph 4, Article 14 the Minamata Convention stipulates that the information on alternative technologies and technology transfer shall be considered at COP2. The Paragraph 5 also stipulates that the COP shall make recommendations on how capacity-building, technical assistance and technology transfer could be further enhanced.

The first Conference of Parties of the Minamata Convention (COP1) held in September 2017 requested the secretariat to seek submissions and reports from Parties and other stakeholders on issues relating to existing initiatives and progress made in relation to alternative technologies, on the needs of parties, particularly developing-country parties, for alternative technologies and on challenges experienced by Parties, particularly developing-country Parties, in technology transfer, and to present the information received to the Conference of the Parties at its second meeting for consideration.

Japan, as an advanced country on mercury management, has developed many technologies and know-hows. The information is compiled in a 2-pages flyer as

'Mercury technology bulletin series'. 10 bulletins listed below are now available (Annexed to this document):

- 001: Mercury Free Technology in the Chlor-Alkali Industry
- 002: Collection of Mercury Waste discharged from Households
- 003: Recovery of Mercury from Fluorescent Lamps
- 004: Mercury Material Flow Analysis
- 005: Monitoring of Mercury in Hair Samples
- 006: Removal of Mercury from Flue Gas using Activated Carbon
- 007: Reduction of Atmospheric Mercury Emission through Improvement of Efficiency of Coal Combustion
- 008: Treatment of Mercury Sphygmomanometers
- 009: Stabilization and Solidification of Mercury
- 010: Monitoring of Mercury in Ambient Air

2. Information relating to the COP1 Decision MC-1/21

The COP1 recognized that some of the existing regional and subregional centres have been already developing projects and activities related with mercury to deliver capacity-building and technical assistance. It recognized capacity-building and technical assistance delivered by other multilateral and bilateral means as well. and through partnerships with private sector. which has been continuously contributing to various mercury-related activities.

Thus. the COP1 decided to collect information on the work undertaken by the existing regional. subregional and national arrangements in delivering capacity-building and technical assistance to assist parties in meeting their obligations under the Minamata Convention (MC-1/21: Capacity-building. technical assistance and technology transfer on the Minamata Convention on Mercury).

Minamata city and its surroundings in Japan is an area affected by the Minamata disease. thus. it was certificated as the Model Environment City concept in 1992. Since then. it lead Japan's eco-friendly city policy with waste segregation. reuse/recycle. reforestation. environmental 'Meister' certificate. etc. Also. it accommodates many organizations and individuals involved in mercury-related

issues. The resources which the area possesses have now become a precious asset to promote the Minamata Convention.

International meetings on mercury that were convened in Minamata in recent years are listed in Table 1 and one-day symposia or celebratory events are listed in Table 2. Minamata city also regularly receives training or visiting programmes that include multiple activities such as lectures, exercises, field visits, etc. The trainings or visits undertaken in the past 12 months are listed in Table 3.

Table 1: International Expert Meetings on Mercury Convened in Minamata

Date	Name, Venue	Participants
22 - 23 June 2015	Asia-Pacific Mercury Monitoring Network Workshop Venue: Umi-to-Yuyake	Countries: 14 (excl. Japan) Participants: 33 (27 from overseas)
29 November - 1 December 2016	Asia-Pacific Expert Workshop on Continuous Atmospheric Mercury Monitoring Venue: Minamata Environmental Academia	Countries: 6 (excl. Japan) Participants: 29 (13 from overseas)
29 - 30 June 2017	Western Pacific Regional Workshop: Health Sector Involvement in Implementation of the Minamata Convention on Mercury Venue: Minamata Environmental Academia	Countries: 18 (excl. Japan) Participants: 43 (25 from overseas)
30 - 31 May 2018	Lessons Learned Workshop of the Minamata Initial Assessment Project in Asia Venue: Minamata Environmental Academia	Countries: 6 (excl. Japan) Participants: 14 (7 from overseas)

Table 2: Events/Symposia on Minamata Convention Convened in Minamata

Date	Name, Venue	Participants
9 October 2013	Commemorative Opening: Diplomatic Conference on Minamata Convention of Mercury Venue: Minamata City Cultural Hall	Countries: 139 Participants: approx. 600 (Simultaneous interpretation provided)
18 October 2014	1st Minamata Convention Forum Venue: Minamata Disease Archives	Participants: approx. 200 (6 from overseas)
24 October 2015	2nd Anniversary of the Adoption of the Minamata Convention Venue: Minamata Disease Archives	Participants: approx. 250
7 October 2016	3rd Anniversary of the Adoption of the Minamata Convention Venue: Minamata Disease Archives	Participants: approx. 250
6 - 7 December 2016	NIMD Forum 2016 Venue: Minamata Disease Archives	Participants: approx. 100 (8 from 4 countries)
1 July 2017	Celebrating Event for the Minamata Convention on Mercury Venue: Minamata Disease Archives	Participants: 184 (35 from 28 countries) (Simultaneous interpretation provided)
21 December 2017	Reporting Event on Participation of Minamata COP1 Venue: Moyai Hall	Participants: approx. 250

Table 3: Training or Visit Programmes Undertaken in Minamata

Date	Training/Visiting	Participants
18 - 20 October 2017	Capacity Strengthening for Multi-media Mercury Monitoring	10 from 10 countries
30 October - 3 November 2017	Capacity Building for Ratification and Implementation of the Minamata Convention on Mercury	9 from 7 countries
11 - 12 December 2017	Group Training Programme for Capacity Development for Addressing Mercury Pollution from ASGM in Indonesia	8 from 1 country

Date	Training/Visiting	Participants
23 - 25 January 2018	International Seminar on Minamata Disease	9 from 7 countries
1 - 2 March 2018	Visit to Japan's Laboratories by Laboratory Analysts in Charge of Mercury Monitoring	8 from 5 countries

In Minamata, regular activities by many organizations can provide various opportunities to the participants/visitors under organized programmes. Organizers can coordinate with relevant facilities/individuals for suitable arrangements that fit to the purposes of the programmes.

One of the local organizers include Minamata Environmental Academia (Academia) that is owned by Minamata Municipal Government. The Academia is a central facility to develop and disseminate information not only on the environmental management technologies, environmental policies or government response, but also local know-hows through collaborative works by utilizing local resources. It provides a pivotal role to establish connections/ties among various stakeholders to promote Minamata.

The activities are classified by types and listed in the Table 4.

Table 4: Regular Activities in Minamata

Facility/Resource	Key Activity
Research	
National Institute for Minamata Disease (NIMD)	Research on Minamata disease in various fields. International collaborative researches. Supports to laboratories in developing countries
Various research laboratories in near-by universities. International Mercury Laboratory Inc.	Environmental impacts and human impacts of mercury. Social impacts of environmental pollutions
Technical development	
NIMD	Rehabilitation for Minamata disease patients
International Mercury Laboratory Inc.	Simple and efficient mercury analysis methods
Educational activities	

Facility/Resource	Key Activity
Minamata Environmental Academia	Organizing public seminars. Organizing training programmes for developing countries
Kumamoto Prefecture Environmental Center	Educational programmes such as segregation of waste mercury-added products
Minamata High School	Volunteer guide at Minamata Disease Municipal Museum. Study programmes on mercury problems in developing countries
Kanshiranui Planning	Organizing environmental study tours for domestic and foreign high school students
Medical services	
Meisuien	Care services. medical services for inpatients
Kyoritsu Clinic	Medical services for patients
Public awareness	
Minamata Disease Municipal Museum	Collection. archiving. displaying information on Minamata diseases. Organizing a Minamata disease storyteller group
Minamata Disease Archives	Displaying scientific information on mercury
Soshisha	Collection and archiving of information on Minamata disease. Operating a private museum. Displaying archived materials
Toomi-no-ie. Hotto Hausu. Orange Hall	Supporting Minamata disease patients (care services. vocational supports. etc.). Supporting story-telling activities by patients at various international and domestic fora
Administrative services	
Department of Policy Planning/Department of Welfare and Environment. Minamata City	Social care services to Minamata disease patients. 'Moyai-naoshi' reconciliation activities. Promoting Model Environment City. Solid waste management (segregation. collection. disposal)
Orange Hall. Moyai Hall. Minamata City Cultural Hall	Providing space and venue for various activities organized by local citizens
Private businesses	

Facility/Resource	Key Activity
Businesses in Eco-town industrial zone	Promotion of environment-oriented businesses such are solid waste management, Reduction of mercury-added products, Renewable energy, Cleaner production, etc.
Miscellaneous	Conservation of terraced paddy, Traditional handicrafts, Organic farming, Cultural heritages, Eco-friendly accommodation, Local specialties and tourism attraction

The facilities available in Minamata enable organizers to plan various types of activities. There are a couple of facilities that can provide venues for international conferences equipped with simultaneous interpretation booth. The largest theatre in Minamata can accommodate up to 800 spectaculars which is equipped with professional audio and visual equipment. Training and workshop venues are also available in a few facilities. The size of each training will depend on the nature of the training. Table 5 summarizes indicative capacities of the facilities available in Minamata.

Table 5: Indicative Capacities of Meeting Facilities in Minamata

Purpose	Capacity	Facility
International Conference	80 participants	• Moyai Hall, Minamata Disease Archives, • Minamata City Community Center
	30 participants	• Minamata Environmental Academia
Symposium / Lecture	800 participants	• Minamata City Cultural Hall
	200 participants	• Moyai Hall, • Minamata Disease Archives, • Minamata City Community Center
	80 participants	• Minamata Environmental Academia, • Orange Hall
Training	50 participants	• Minamata Environmental Academia, • Kumamoto Prefecture Environmental Center
Note: Numbers of facilities possess many small meeting rooms or tatami-mat rooms. Some tatami-mat rooms are available for stay-in trainings (Soshisha)		

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Mercury Technology Bulletin Series: 001

Mercury Free Technology in the Chlor-Alkali Industry

Background

Mercury Use in the Chlor Alkali Industry

The mercury-cell process has been widely used for the production of chlorine and caustic soda. Concerns about the environmental impact of using mercury have led to a reduction in the number of mercury-cell. However, the process itself is still widely used in many countries.

Requirement of the Minamata Convention on Mercury (Article 5 and Annex B)

Article 5 of the Minamata Convention regulates manufacturing processes using mercury or mercury compounds. It is stated that the mercury use for Chlor-alkali production shall be phased-out **by 2025**

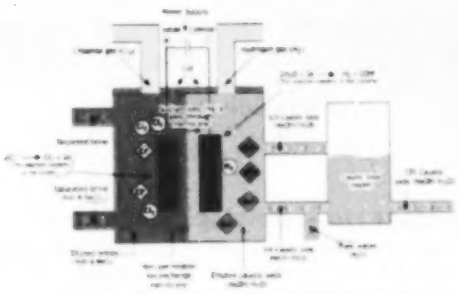
Overview of the Technology

Types of processes used in the Chlor-Alkali Industry

Caustic soda (sodium hydroxide) and chlorine are predominantly manufactured by the electrolysis of sodium chloride solution (Brine). Conventionally, *mercury process* and *diaphragm process* were used for the electrolysis process. Using *ion exchange membrane process* provides a lot of economic and environmental advantages and hence the conventional processes are being replaced by the ion exchange membrane process.

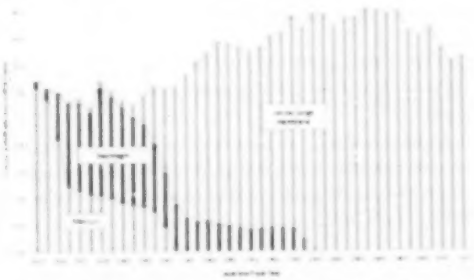
Mercury process, as the name suggests, utilizes mercury in the production process and is being phased out due to environmental challenges associated with the use of mercury. *Diaphragm process* utilizes diaphragm consisting of asbestos to separate the anode and cathode. The design of the *Ion exchange membrane process* is similar to diaphragm cell except that a cation permeable membrane acts as an ion exchanger and divides the cell into two sections. Only sodium ions and a little water pass through the membrane. Chlorine is collected at the anode. The consumption of electricity in this method is the lowest of the three processes This method is more efficient than the diaphragm method and newly constructed plants exclusively use this method.

Ion exchange membrane process



Source: Euro Chlor (http://www.eurochlor.org)

Trend of caustic soda production by process in Japan



Source: "Lessons from Minamata Disease and Mercury Management in Japan (Ministry of the Environment, Japan) https://www.env.go.jp/chemi/tmms/pr m/mat01/en_full.pdf

Trend to mercury free technology in Japan

During the rapid economic growth period in the 1970s, the mercury-cell process was most common in the chlor-alkali industry, and the amount of mercury used in this process accounted for more than half of the total amount of mercury used in Japan. In Japan, as a result of effort made by the industry, all mercury cell processes were converted to mercury free process by 1986. Since 1999, ion-exchange membrane process is the only process used in the chlor-alkali facilities of Japan.

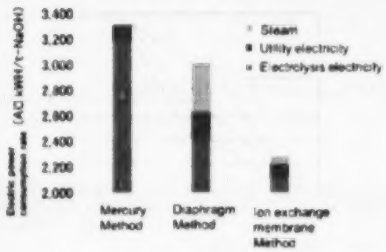
Mercury Technology Bulletin Series:

Advantages/Strengths

Co-Benefits from Conversion

When the Japanese industry started to use the ion-exchange membrane, they encountered issues of high energy cost and poor quality of caustic soda. However, extensive R&D has led to the improvement of electric current efficiency to 96% or more. The total energy consumption is lower by more than 30% compared to the diaphragm or mercury-cell processes, while yielding a better quality (higher purity) product.

Energy efficiency comparison



Source: AGC Inc.

Ion-exchange membrane equipment

Photo provided by AGC Inc.

Conversion to ion-exchange membrane ensures the following **"CO-BENEFITS"**: the reduction of energy consumption and the elimination of hazardous chemicals (e.g., mercury, asbestos) in the system. Furthermore, membranes manufactured in Japan have a high durability (long lifetime) thus ensuring stable operation of the system; these are factors essential for profitable operations of the chlor-alkali industry.

Applicability

World wide Use

Japanese ion-exchange membranes are used in salt electrolysis plants in over 50 countries all over the world.

Challenges to Technology Adoption

Although ion-exchange membrane processes are more energy conserving and profitable than mercury-cells in the long run, the initial investment cost for the process conversion is high. Therefore, it takes many years for the initial cost to be recovered from the revenue of the converted facility.

The excess mercury recovered from decommissioned mercury cell must be disposed of in environmental sound manner. As the waste management is not profit-producing component, the overall conversion process must incorporate the waste management within the feasibility study.

Further Reading

Detailed information about this technology can be found in the following website.

- Lessons from Minamata Disease and Mercury Management in Japan (https://www.env.go.jp/chemi/tmms/pr-m/mat01/en_full.pdf)
- UNEP, Mercury Reduction in the Chlor-Alkali Sector (http://www.unep.org/chemicalsandwaste/global-mercury-partnership/mercury-reduction-chlor-alkali-sector)

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Environmental Health Department
Ministry of the Environment, Japan
1-2-2 Kasumigaseki, Chiyoda-ku Tokyo, 100-8975, Japan
Tel: +81-(0)-3-5521-8260, E-Mail: suigin@env.go.jp
http://www.env.go.jp/en/chemi/mercury/mcm.html

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Mercury Technology Bulletin Series: 002

Collection of Mercury Waste discharged from Households

Background

Requirement of the Minamata Convention on Mercury

Under Article 11 of the Minamata Convention on Mercury, each Party is required to take appropriate measures so that mercury waste is managed in an environmentally sound manner.

The Convention identifies three categories of mercury wastes:
(1) wastes consisting of mercury or mercury compounds,
(2) wastes containing mercury or mercury compounds and
(3) wastes contaminated with mercury or mercury compounds.

Environmentally Sound Management (ESM) of waste mercury products (e.g., waste fluorescent lamps and batteries) is a common challenge for all developing countries, since mercury and its compounds are used in various products for our daily lives. Developing mechanisms for source separation and collection of mercury waste discharged from households is essential for the implementation of the Convention.

Source: UNEP "Practical Sourcebook on Mercury Waste Storage and Disposal"

Overview of the Technology

Due to increasing social concern about mercury since the outbreak of Minamata Disease, Japan has formulated and incrementally developed a collection system for waste mercury-added products generated from households.

In Japan, the local governments are responsible for collecting mercury waste generated from households. The system comprises of utilizing the existing collection system, including door-to-door collection and curbside collection, suited to the characteristics of the locality. Collection boxes are placed at various points where consumers visit frequently, for example at consumer-electronics retailer shops for waste fluorescent lamps/batteries and pharmacies for used thermometers, ensuring that an efficient collection system is in place.

Companies licensed by the local municipalities are contracted to recycle and dispose of mercury waste discharged from households that is collected by the municipality, in an environmentally sound manner.

Example of Collection System of Waste Fluorescent Lamps disposed from Households in Japan

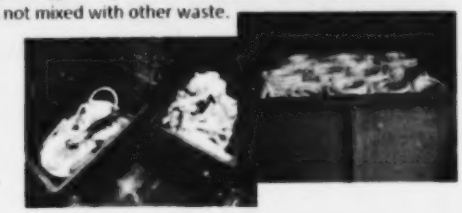
Mercury Technology Bulletin Series:

Advantages/Strengths

Measures to prevent breakage during disposal and transportation

Waste mercury-added products such as thermometers or fluorescent lamps are fragile and there is a possibility of mercury spilling and scattering, resulting in the pollution to the environment. Furthermore, the appropriate treatment methods vary according to different types of products and it is essential to take appropriate measures to ensure that mercury waste is not mixed with other waste.

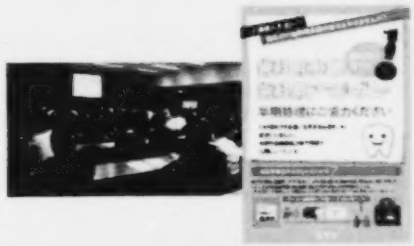
The specific measures in practice include using containers suited to the shape, size and quantity of the waste to ensure the prevention of breakage, which improves the waste collection rate as well as pollution prevention.



Awareness raising among local governments and citizens

For segregation and collection of municipal waste to be carried out effectively, it is crucial that the stakeholders cooperate and have a clear and common understanding of pertinent issues. In Japan, an effective collection system has been established through institution building while simultaneously raising awareness of stakeholders.

The MOEJ has developed guidelines with examples of the actual cases and good practices of mercury waste collection by municipality , along with other awareness raising pamphlets. Additionally, seminars for local governments are also organized occasionally.



Applicability

Japan has developed one of the most effective waste segregation and collection systems of mercury waste in the world. This has been possible due to the cooperation and understanding of the public.

Establishing such system will be challenging, but the Japanese approach can be a good reference and the know-hows can be applied to the establishment of similar approach in other countries. Furthermore, the Japanese experience of policy formulation, carrying out awareness raising activities, and carrying out the collection system by local governments can provide valuable information for establishing segregation and collection systems for mercury wastes in other countries.

Further Reading

MOEJ, Collection Methods of Waste Mercury-added Products discharged from Households (English DVD)
MOEJ, Guidelines for Separation and Collection of Mercury Containing Waste discharged from Households (Japanese only) (http://www.env.go.jp/recycle/waste/mercury-disposal/h2712_guide1.pdf)

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1-2-2 Kasumigaseki, Chiyoda-ku Tokyo, 100-8975, Japan
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http://www.env.go.jp/en/chemi/mercury/mcm.html

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Mercury Technology Bulletin Series: 003

Recovery of Mercury from Fluorescent Lamps

Background

Article 11 of the Minamata Convention on Mercury requires each Party to take appropriate measures so that mercury waste is managed in an environmentally sound manner. Mercury contained in waste products such as fluorescent lamps and batteries need to be recovered to the extent possible, in order to prevent contamination of the environment from improper handling of these products. However, mercury is an element, and unlike other organic pollutants cannot be treated easily with conventional treatment measures.

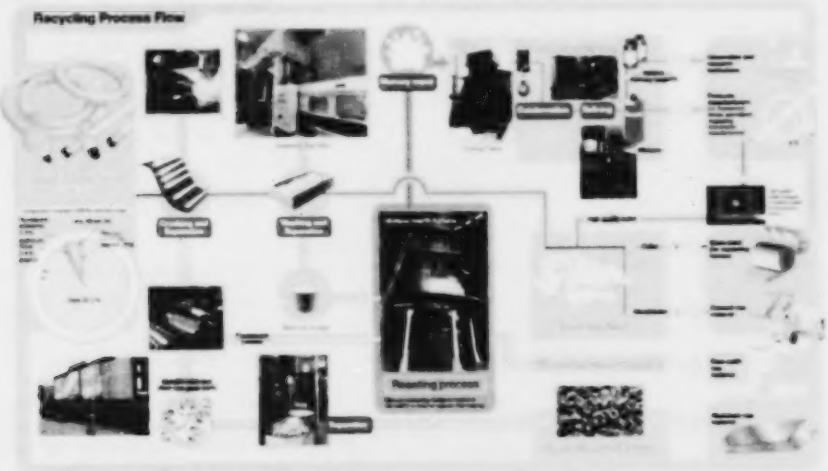
Website of UNEP

Overview of the Technology

This technology involves the recovery of mercury from fluorescent lamps. This involves the separation of the components (glass, fluorescent power, aluminum, etc.) followed by a process to increase the purity of the mercury. Although this general process is the same across all companies, the exact process may slightly differ according to the process adopted by each company.

The process employed by the largest recycler of fluorescent lamps in Japan is described below. In this plant, fluorescent lamps brought into the facility are pre-treated in a crusher and sorting facility where the glass, cap and fluorescent powder are separated. Aluminum is recovered while the glass is washed, and mercury is separated along with other fine particles. The resulting mercury sludge is passed onto a multiple hearth furnace (Herreshoff furnace), and is treated at a temperature of 600-800 degrees Celsius where the mercury is vaporized. The mercury vapor then passes through a condenser, where it is cooled and returns to liquid mercury. The collected mercury is refined and recovered as 'high purity' mercury.

Used Fluorescent Lamp Recycling System



Source: Website of Nomura Kohsan Co., Ltd. (http://nkcl.jp/wp-content/uploads/2014/07/recycle_flow1.pdf)

Mercury Technology Bulletin Series:

Advantages/Strengths

High recovery rate of mercury

The recovery rate of mercury is quite high, meaning that very little mercury contained in the fluorescent lamps is discarded into the environment. Furthermore, the mercury recovered is of high purity, and this is recycled through means allowed by the Minamata Convention.

Recycling of components

In addition to mercury, this process allows for the recovery of other materials like aluminum and glass. The collected aluminum is also recycled whereas the remaining fluorescent powder after mercury extraction is used as a raw material for rare earth elements . Collected glass can be recycled to make raw materials for fluorescent lamps, glass wools, etc. These processes ensure that the fluorescent lamp is treated in an Environmentally Sound Manner as required by the Minamata Convention.

Photo provided by Nomura Kohsan Co., Ltd

Safety

Although the most of the process is automated, the workers carrying out some manual works use gloves and masks to prevent their exposure to any fugitive mercury; hence the process is considered very safe.

Applicability

No restriction on shape or size

Fluorescent lamps of any shapes or sizes, including Circular lamps, linear lamps, ball shaped lamps, CFLs, CCFLs, can all be treated using this method (some manual work is required to remove the coatings for lamps with anti-shattering coatings)

Proven Track record

This treatment method of fluorescent lamps is currently successfully being practiced in Japan. Furthermore, fluorescent lamps have been brought from other countries into Japan, through the procedures required by the Basel Convention, for the purpose of treatment and recovery of mercury. This arrangement has helped ensure an environmentally sound treatment of fluorescent lamps generated overseas, which otherwise may not have been possible.
Japanese recycling companies have installed lamp crushers in the partner countries to reduce transportation cost by volume reduction, subsequently supporting to promote the recycling of fluorescent lamps in the partner country.

Japanese lamp crusher installed in the Philippines

Photo provided by Nomura Kohsan Co., Ltd

Further Reading

UNEP, Practical Sourcebook on Mercury Waste Storage and Disposal
(http://www.unep.org/chemicalsandwaste/global-mercury-partnership/mercury-waste-management/activities-and-projects/practical-sourcebook)

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Mercury Technology Bulletin Series: 004

Mercury Material Flow Analysis

Background

Requirement of the Minamata Convention on Mercury

Baseline information of mercury use and its emission and release is essential for national policy-making, and for identifying the mercury emission hotspots in the respective countries. Under the Convention, Parties have several obligations relevant to inventory development and reporting. The information obtained through reporting is used for evaluating the effectiveness of the Convention.

Article 8 (Emissions) and Article 9 (Releases)
Parties shall establish and maintain thereafter, an inventory of emissions/release from relevant sources.

Article 19 (Research, Development and Monitoring)
Parties shall endeavor to cooperate and develop/improve inventories including information of the use, consumption, and anthropogenic emissions into the atmosphere, and releases to the water and land of mercury and mercury compounds.

Article 21 (Reporting)
Parties shall include the information as called for in Articles 3, 5, 7, 8 and 9 of this Convention in its reporting.

Article 22 (Effectiveness Evaluation)
The Conference of the Parties (COP) shall evaluate the effectiveness of this Convention. Evaluation shall be conducted on the basis of available information, including those obtained from: (a) reports and other monitoring information provided to the COP; and (b) reports submitted pursuant to Article 21.

Overview of the Technology

Japanese Experience of Mercury Material Flow Development.

Japan has developed and upgraded the "**Mercury Material Flow (MMF)**", which contains comprehensive information on the flow of mercury in Japan through its life cycle, since 2007.

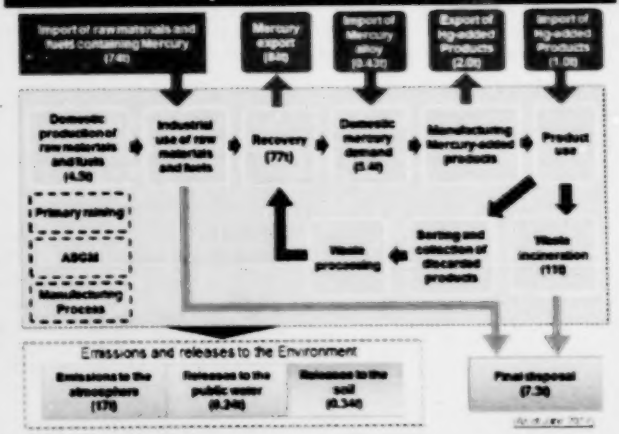
In order to develop the MMF, the Ministry of the Environment, Japan (MOEJ) took the lead in data collection, in cooperation with other governmental bodies and industries. MOEJ also established a Technical Committee with experts from the academia and industry, with various backgrounds.

In order to estimate the overall mercury flow in Japan, MMF utilizes all available information, such as those listed below.:

- Statistical data
- Monitoring data
- Data obtained from interview with industries
- Questionnaire surveys to local government
- Research results

Year	Historical activity
2007	Development of the 2005-base MMF
2009	Active discussions and studies of the MMF initiated
2011	Update of the 2005-base MMF to 2010-base MMF
2017	Development of the 2014-base MMF

The Mercury Material Flow in Japan (2014)


Import of raw materials and fuels containing Mercury (7.6t)
Mercury export (84t)
Import of Mercury alloy (0.42t)
Export of Hg-added Products (2.0t)
Import of Hg-added Products (1.0t)
Domestic production of raw materials and fuels (4.5t)
Industrial use of raw materials and fuels
Recovery (77t)
Domestic mercury demand (5.4t)
Manufacturing Mercury-added products
Product use
Primary mining
ASGM
Manufacturing Process
Waste processing
Sorting and collection of discarded products
Waste incineration (11t)
Emissions and releases to the Environment
Emissions to the atmosphere (17t)
Releases to the public water (0.24t)
Releases to the soil (0.34t)
Final disposal (7.3t)

*No operation in Japan

Mercury Technology Bulletin Series:

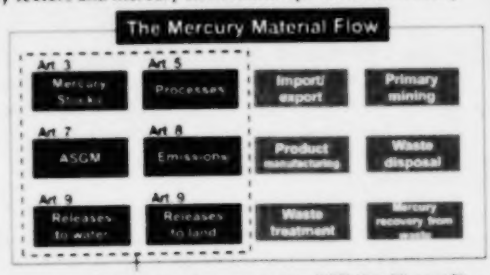
Advantages/Strengths

Database Supporting the Policy Making and Reporting Process

Many countries are in the process of preparing a national mercury emission inventory as part of the *"Minamata Initial Assessment (MIA)"*, using the *"Toolkit for identification and quantification of mercury releases"* developed by UNEP. This is an effective tool for countries at the initial stage of developing a preliminary inventory.

Japan's MMF, however, also covers other aspects not covered by the UNEP Toolkit, and visually presents the life-cycle flow of mercury in the country by integrating relevant information. Moreover, the MMF provides more accurate estimate of mercury flow compared to the Toolkit since it is based on actual country-specific information. The method used for developing MMF assists policy makers to obtain a clear and accurate understanding of the overall picture of the mercury flow and to identify the key sectors and mercury emission hotspots where mercury management must be improved on a priority basis.

Furthermore, the MMF also assists the competent authorities in fulfilling their reporting obligations since it contains all the information required to report to the COP, pursuant to Article 21 para2 of the Convention. If updated and upgraded periodically, the MMF could also be used to examine the impact and effectiveness of domestic policy measures.



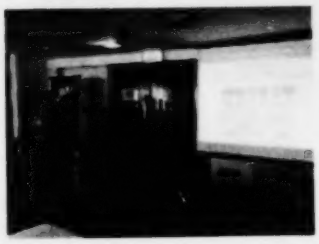
Information required to be reported to COP (Art.21 para2)

Applicability

Potential to develop MMF in your country

Mercury inventory to be developed using UNEP Toolkit is a good initial step for countries to understand their current situation of mercury emissions. Japan is able to share its expertise to develop a more comprehensive MMF after this initial step, if there is need from the partner countries.
Japanese experts have shared their know-how and experiences in developing MMF at a series of workshops organized by MOEJ in ten partner countries. The next step would be the consultation with the stakeholders to obtain useful information such as the monitoring data and reports published by international organizations for the partner countries.

Presentation by a Japanese expert in a workshop held in Kenya



The lack of information/data is a common challenge for developing countries. Japan's support to developing countries in searching appropriate methodologies to collect or develop data/ information will provide the most relevant basis on the circumstances of each country.

Further Reading

MOEJ, Outcomes of Mercury Material Flows Analysis (Japanese only)
(http://www.env.go.jp/chemi/tmms/materialflow.html)

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1-2-2 Kasumigaseki, Chiyoda-ku Tokyo, 100-8975, Japan
Tel: +81-(0)-3-5521-8260, E-Mail: suigin@env.go.jp
http://www.env.go.jp/en/chemi/mercury/mcm.html

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Mercury Technology Bulletin Series: 005

Monitoring of Mercury in Hair Samples

Background

People engaged in activities using mercury or consuming food containing mercury such as fish are 'exposed' to mercury. Thus it is essential to monitor the level of human exposure and develop appropriate strategies to address the resulting health impacts. Article 19 of the Minamata Convention also calls on the parties to cooperate and develop and improve monitoring of mercury and its compounds, particularly in vulnerable populations and environmental biota.

Japanese experience of the Minamata disease in the 1950s, caused by ingestion of methylmercury via contaminated fish, resulted in various groundbreaking research on mercury. Hence, Japan now possesses various technologies related to mercury identification, management and risk reduction.

Source : Website of NIMD

Overview of the Technology

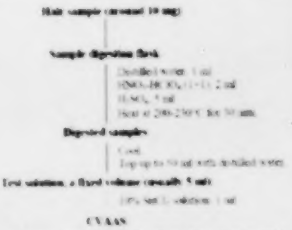
Analysis of Mercury in human bio samples like scalp hair are useful methods for evaluating the level of human exposure and burden to the human body from mercury exposure. Hair is the most suitable media for estimating methylmercury exposure of humans.

However, the mercury concentration in hair can increase as a result of adhesion of external mercury vapor and inorganic mercury . In cases of no exposure to external inorganic mercury or mercury vapor, almost all mercury in hair is in the form of methylmercury; therefore, the level of methylmercury exposure from diet can be evaluated by measuring total mercury. However, since people involved in gold mining and gold refining have a high risk of contamination from metallic mercury and mercury vapor, evaluation of actual methylmercury exposure is possible only by measuring methylmercury as well as total mercury in hair.

The National Institute for Minamata disease (NIMD), under the Ministry of the Environment, Japan (MOEJ), has carried out multiple researches to develop analytical methods for mercury, and published a "**Mercury Analysis Manual**". Analytical methods for measuring total mercury in hair samples is described below. Conventional methods for measuring total mercury include absorption spectrometry (dithizone colorimetry), neutron activation analysis, X-ray fluorescent spectrometry and cold vapor atomic absorption spectrometry (CVAAS). CVAAS is superior to other methods in terms of sensitivity, convenience, and cost-effectiveness. CVAAS is classified into reduction/aeration procedure and sample combustion procedure according to the generation mode for mercury in the elemental form. The former involves wet digestion with a mixture of strong acids following my addition of a reducing agent to generate mercury in the elemental form , whereas the latter involves elemental vapor generation through direct combustion of the sample. Analysis method for hair samples using wet digestion , reduction and CVAAS offers substantial improvements over the conventional method and has been explained in detail in the "Mercury Analysis Manual".

In Japan, data obtained from biomonitoring (including scalp hair samples), is used for implementing various policy measures, aimed at protecting human health. For example, the report: "Advice for Pregnant Women on Fish Consumption and Mercury" has been prepared by the Ministry of Health, Labor and Welfare, which provides a guide on the types and amounts of fish that can be safely consumed.

Determination of total mercury in hair



Source : Mercury Analysis Manual, MOEJ

Apparatus for reduction/aeration

Source : Website of NIMD

Mercury Technology Bulletin Series:

Advantages/Strengths

Ease of sampling

Mercury analysis through hair samples is simple, and it is a non-invasive sampling method where samples are also easy to preserve. Since the hair grows at a rate of roughly 1cm per month, evaluation of past exposure is also possible.

Hair Weighing

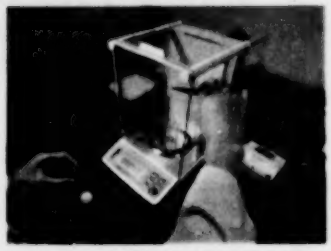


Photo provided by IDEA Consultants, Inc.

Decent tool for policy making and concrete action

For people concerned about their mercury exposure, providing their hair sampling results can be useful to help decision makers formulate policies, and take concrete actions to protect the population from mercury exposure.

Data accuracy

Methods developed by Japan using CVAAS for the analysis of total mercury is a highly sensitive method and offers substantial improvements over the conventional methods, hence providing much more accurate data.

Applicability

Sampling and analysis of hair samples can be done easily and accurately, by following the mercury analysis manual prepared by NIMD.

Measurement using CVAAS

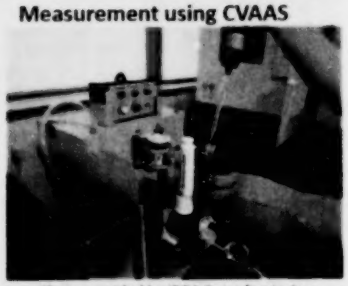


Photo provided by IDEA Consultants, Inc.

Further Reading

National Institute for Minamata Disease – Japan (NIMD)
(http://www.nimd.go.jp/english/index.html)

Advice for Pregnant Women on Fish Consumption and Mercury (2005)
(http://www.mhlw.go.jp/topics/bukyoku/iyaku/syoku-anzen/suigin/dl/051102-1en.pdf)
*this version has been updated in 2010 – Updated Japanese version is available at
(http://www.mhlw.go.jp/topics/bukyoku/iyaku/syoku-anzen/suigin/dl/index-a.pdf)

MOEJ, Mercury Analysis Manual
(http://www.nimd.go.jp/kenkyu/docs/march_mercury_analysis_manual(e).pdf)

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Mercury Technology Bulletin Series: 006

Removal of Mercury from Flue Gas using Activated Carbon

Background

Control of emission of mercury and its compounds to the atmosphere from various industrial sources is essential in decreasing the total emission of mercury. Article 8 of the Minamata Convention requires for the control and reduction of mercury and its compounds to the atmosphere through measures to control emission from point sources falling within the source categories listed in Annex D of the convention (Coal-fired Power Plants, Coal-fired Industrial Boilers, Smelting and roasting processes used in the production of non-ferrous metals, Waste incineration facilities and Cement Clinker production facilities).
For countries that are in a phase of transition to industrialized economy, increase in the number of facilities specified in Annex D of the Minamata Convention can be expected. In order to prevent and alleviate atmospheric pollution from these facilities, application of BAT is deemed to be essential.

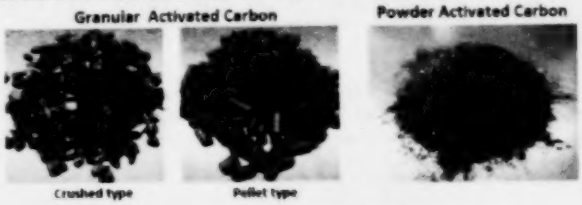
Overview of the Technology

Facilities with combustion processes like incinerators, boilers, cement kilns etc. are typically equipped with a combination of various flue gas treatment devices like denitrification devices, Fabric Filters(FF), Dry or Wet Scrubbers, Flue gas Desulphurization (FGDs) units etc.

Although these devices are effective in reducing the emission of mercury to a certain extent, they are designed for the treatment of NOx, SOx, PM etc. and not specifically for the removal of mercury from flue gases.

In Japan, after the bitter experience with Minamata disease, an increase in public awareness to mercury has resulted in the development of various products that utilize activated carbon and now it is deemed to be a proven and effective technique for controlling the emission of mercury from flue gas. Due to their high degree of microporosity, activated carbons have a large surface area and hence mercury present in the flue gas is adsorbed into the activated carbon, thus preventing its emission. Activated carbon can either be installed in the form of pellets in an activated carbon tower, or through the injection of activated carbon into the flue gas (activated carbon sorbent injection). In Japan, various types of gas treatment devices that utilize activated carbon are used in incineration plants to control mercury emissions.

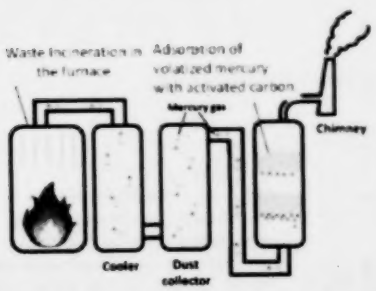
Granular Activated Carbon | **Powder Activated Carbon**



Crushed type | Pellet type

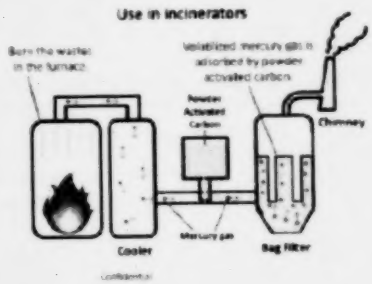
Photos provided by Ajinomoto Fine-Techno Co., Inc.

Mercury removal from a typical incineration plant using Granular activated carbon



Mercury removal from a typical incineration plant using Powder activated carbon

Use in incinerators



Source: Ajinomoto Fine-Techno Co., Inc.

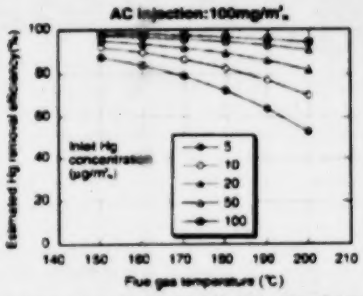
Mercury Technology Bulletin Series:

Advantages/Strengths

Effective Removal of Mercury

Activated Carbon is very effective in the removal of mercury and although factors like temperature, inlet mercury concentration impact the performance, the removal efficiency of mercury can reach to over 90%. Using Activated Carbon, in conjunction with other flue gas treatment methods, can further improve mercury removal efficiency.

Mercury Removal Efficiency of Activated Carbon Injection in incinerators of municipal solid waste (MSW)



Source : Japan Environmental Facilities Manufacturers Association

Products with Enhanced Performance

Activated Carbon products that provide enhanced performance compared to traditionally used ones have been developed. These products have a comparatively higher adsorption potential (up to 1000 times) ensuring that the flue gas treatment device can be smaller in size. As these products last longer, they do not need to be replaced as often. This helps in reduction of the amount of waste generated, contributing to the reduction of the total operation cost of the flue gas treatment devices. These products also provide improved stability at higher temperature.

Activated Carbon products with enhanced performance

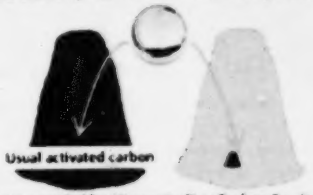


Photo provided by Ajinomoto Fine-Techno Co., Inc.

Applicability

Mercury control needs to considered as part of a comprehensive pollution control measure that includes other pollutants. From the viewpoint of mercury removal, activated carbon is considered to be one of the most effective methods for the removal of mercury and is being successfully used in facilities like incinerators to control emission of mercury from flue gas.

Activated Carbon products come in various forms like granular (crushed type/pellet type), powders which have been engineered into various forms like towers or sorbent powders. Depending upon the requirement, the appropriate product can be chosen and applied.

Further Reading

MOEJ, Technologies for the treatment of flue gas from incinerators (Japanese only)
(https://www.env.go.jp/council/07air-noise/y079-03/mat02_7.pdf)

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Mercury Technology Bulletin Series: 007

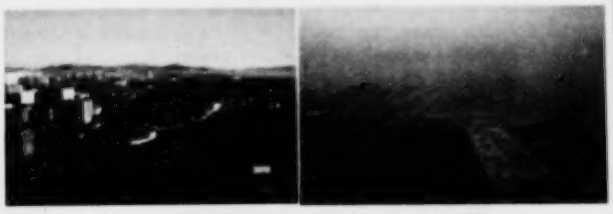
Reduction of Atmospheric Mercury Emission through Improvement of Efficiency of Coal Combustion

Background

In some cold countries, combustion of coal for heating purpose is a common practice. This results not only in the emission of CO_2 from households and buildings that contributes to global warming, but also increase in the emission of other pollutants, including mercury contained in coals, causing an aggravation of atmospheric pollution during cold months.

Although this particular source of mercury emission is not listed in Annex D of the Minamata Convention and therefore is out of the scope of Article 8, it is nevertheless an important issue that has been identified as a priority by some countries and requires action to alleviate air pollution and hence protect human health and the environment. This document introduces a technology , as exemplified with a project in Mongolia, that can be utilized for the reduction of atmospheric emissions of conventional air pollutants through improvement of efficiency of coal combustion.

Air pollution in Ulaanbaatar



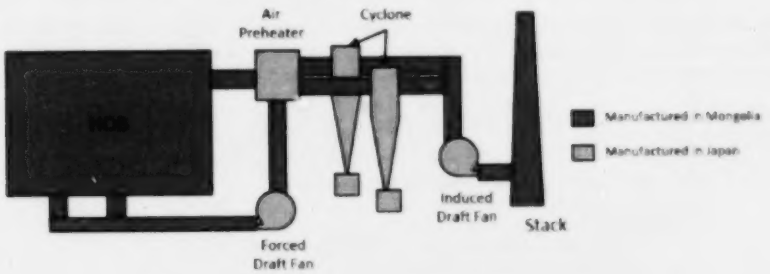
Summer Winter

Overview of the Technology

In some countries with cold climate, a large amount of coal is used for the purpose of heating during winter time. In addition, in urban areas many apartment complexes and school buildings use HOBs (Heat Only Boilers) for heating purpose as well. These HOBs tend to be old and rudimentary with an inferior combustion efficiency which can lead to serious problems of atmospheric pollution resulting in restriction of visibility even during day time.

In addition to the mass consumption of coal, inefficiency of coal combustion by existing HOBs also contributes to the deterioration of air quality.

Overview of the Upgrade of HOB



Source: Overseas Environmental Cooperation Center, Japan

Existing Heat Only Boilers (HOBs) can be upgraded to obtain a stable combustion, to reduce coal consumption and emission of air pollutants, to improve thermal efficiency and to reduce HOB dust. The improvement includes the upgrading of Cyclone (improvement of flow dust collection), upgrading of Air Preheater (replacement of heat exchange tube) and improvement of Forced Draft Fan and Induced Draft Fan (air flow adjustment, using corrosion protection material). The upgrading of HOBs in Mongolia has resulted in the reduction of coal consumption amount with the co-benefit of reduction in the emission of NOx, SOx, CO_2 and dust.

Mercury Technology Bulletin Series:

Advantages/Strengths

Co-benefit of reduction of pollutants

A major advantage is that the prevention of emission of a variety of air pollutants can be achieved along with decrease in the emission of CO_2, while simultaneously benefiting from the increase in the amount of power generated due to efficiency improvement. In this example, the following reductions were achieved :

Coal consumption: Reduction of 10-30 % CO (Carbon monoxide) Exhaust: Reduction of 30-60 %
NOx , SOx Exhaust: Reduction of 8-20 % Dust Exhaust: Reduction of 50-80 %

Reduction of coal consumption and dust exhaust also leads to the reduction of emission of heavy metals (Hg, Se, etc.).

Co-benefit of improvement to operation and maintenance

Improvement of boiler also results in the improvement of the safety of the workers through improvement in the work procedures, improvement of indoor air quality in the boiler room (through reduction of soot, fire overflow) and improvement in safety.

Before modifications

After modifications

Applicability

Over 1,000 HOBs are in operation in Mongolia. The improvement of coal combustion efficiency using Japanese boiler technology contributes to co-benefit of pollution control, reduction of mercury emission and decrease of coal consumption. This technology can also be applied to other partner countries.

Depending on the requirement and availability of funding sources, the improvements can be carried out incrementally in multiple stages. Further, Japanese technology can be utilized for manufacturing of required components locally, hence making it possible to keep the cost down.

Further Reading

MOEJ, JCM Project in Mongolia (Japanese only)
(https://www.env.go.jp/press/102859.html)
IGES, Workshop on JCM
(https://www.iges.or.jp/en/climate-energy/mm/20151110_1.html)
Carbon market express, Project Details
(https://www.carbon-markets.go.jp/eng/en_column/en_energy_efficiency/1780/)

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Mercury Technology Bulletin Series:

008

Treatment of Mercury Sphygmomanometers

Background

Requirement of the Minamata Convention on Mercury

Article 4 of the Minamata Convention requires the phase out of mercury added product including sphygmomanometers containing mercury by 2020.

Mercury contained in these devices needs to be recovered to the extent possible, in order to prevent contamination of the environment from improper handling of these products. However, mercury is a chemical element, and unlike other organic pollutants, cannot be treated easily with conventional treatment measures.

Furthermore, Article 11 of the Convention requires each Party to take appropriate measures so that mercury waste is managed in an environmentally sound manner. Sphygmomanometers contain about 50 grams of mercury. Hence, mercury should be extracted from these devices and treated/disposed in an environmentally sound manner.

Sphygmomanometers with mercury

Overview of the Technology

Sphygmomanometers are manually dismantled under fumed hoods which are setup inside an enclosed dismantling facility. The dismantling facility is closed off from other areas to prevent accidental leaking of mercury vapor to other areas.

Mercury vapor generated in the fume hood or the facility is processed through the exhaust air treatment process using activated carbon. Mercury is collected in an iron bottle attached to the bottom of the fume hood. Workers are required to wear hard hats, masks, goggles and work clothing and gloves. Parts that come in contact with mercury are dismantled separately from those that do not. All the parts are collected separately according to the composition of the material. Dismantling of the mercury tank itself is carried out inside a fume hood. Iron and aluminum are recycled whereas glass and other materials are treated further by roasting (600°C to 800°C) where mercury is vaporized and collected.

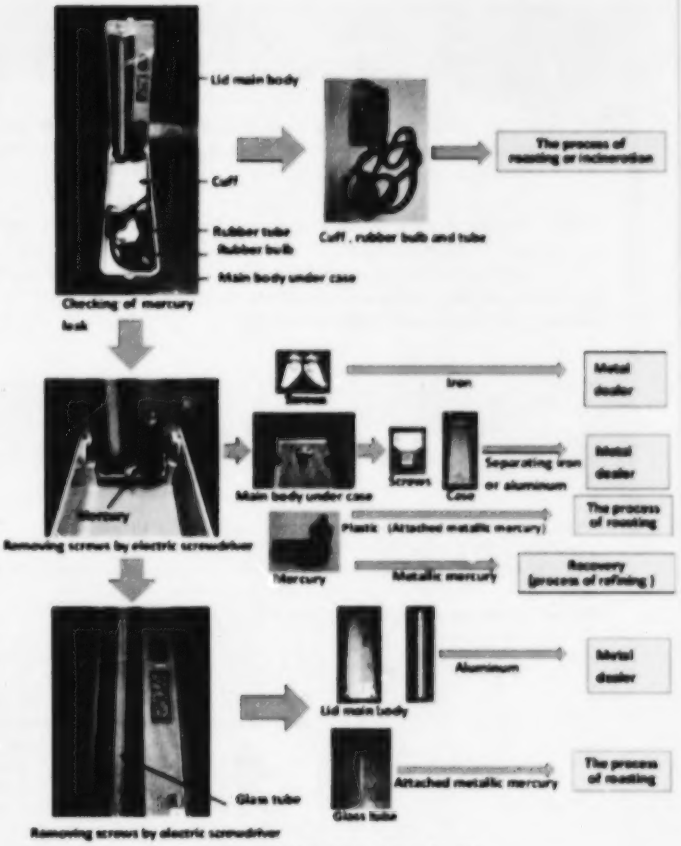

Photo provided by Nomura Kohsan Co., Ltd.

Mercury Technology Bulletin Series:

Advantages/Strengths

High recovery rate of mercury

A combination of manual dismantling and roasting ensures that the recovery rate of mercury is very high. On average, about 50g of mercury is recovered from one sphygmomanometer.

Safe and environmentally friendly method

Combination of fumed hood and sound care during dismantling ensures that no leakage of mercury occurs. Any material that comes in contact with mercury is sent for roasting whereby the mercury is vaporized and collected. Workers use safety gears while dismantling ensuring that the process is safe and environmentally friendly.

Recycling of components

One advantage of manual segregation is that in addition to recovery of mercury, other components of the devices like iron, aluminum, etc. can be separated and recycled.

Dismantling process

Photo provided by Nomura Kohsan Co., Ltd.

Applicability

In many countries, phase out of mercury containing medical measuring devices is being promoted through their health ministries. However, there is a lack of institutional framework to treat these devices once they become waste.

Hence, these devices end up being stored in containers inside interim storage facilities located within the hospital premises until an adequate treatment/disposal method becomes available. Japan has a lot of experience and know how on safe methods of handling of mercury containing medical measuring devices without breakage. Further, Japan also has established a scheme to collect thermometers and sphygmomanometers from households and hospitals which can be of reference to other countries.

Further Reading

UNIDO, Nomura Kohsan's mercury waste management technology
(http://www.unido.or.jp/en/technology_db/1716/)
MOEJ, Guidelines for Separation and Collection of Mercury Containing Waste discharged from Households (Japanese only)
(http://www.env.go.jp/recycle/waste/mercury_disposal/h2712_guide1.pdf)

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Mercury Technology Bulletin Series:

009

Stabilization and Solidification of Mercury

Background

The Minamata Convention on Mercury has placed various restrictions on usage, import and export, and transboundary movement of mercury. The demand for mercury is expected to decrease in the future as the usage of mercury will only be allowed for certain uses specified in the Convention. Article 11 of the Minamata Convention calls for each Party to take appropriate measures to manage mercury waste in an environmentally sound manner. Hence, mercury that has become surplus will become waste and will require environmentally sound management (ESM). Furthermore, the Minamata Convention requires the phase out of Chlor-Alkali production facilities using mercury by 2025 and a lot of excess mercury is expected to be generated as a result. The paragraph 5 (b) of the Article 3 of the Convention specifically requires the environmentally sound disposal of excess mercury from the decommissioning of chlor-alkali facilities. Hence it is expected that the ESM of waste elemental mercury will become a very important issue and a common challenge for many Parties in the future.

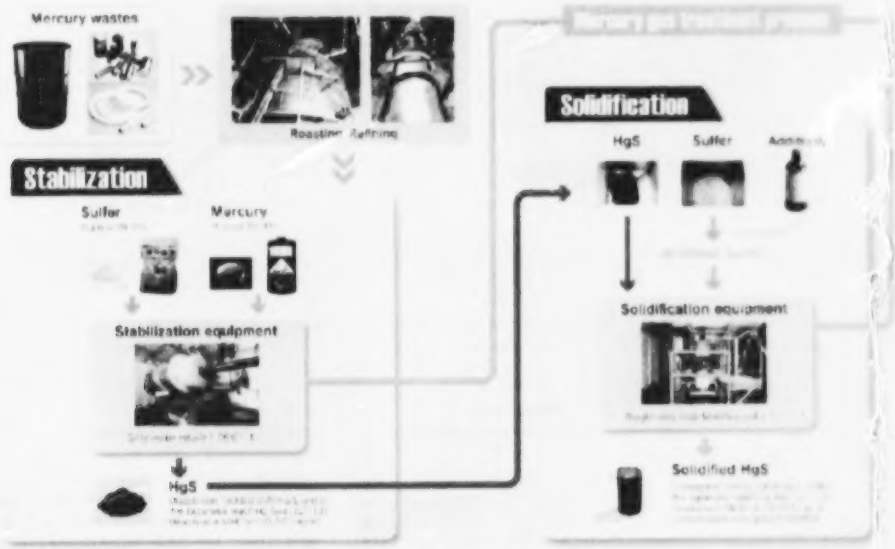
Overview of the Technology

Technology includes the process of stabilization using sulfur and subsequent solidification of the stabilized product.

Stabilization of elemental mercury is carried out by mixing mercury with pure sulfur (purity >99.9%) and treatment in a specialized equipment. The end product is Mercury Sulfide (HgS).

The stabilized mercury can also be treated through a solidification process if required by national regulations. It involves the mixing of the treated HgS with sulfur and special additive in a fixed ratio in a controlled environment of a specialized device. The end product is solidified HgS that can be safely disposed in a landfill or in an underground mine (Dissolution test =< 0.005mg/L, Headspace method < 0.001mg/m³, Compressive strength >= 0.98 Mpa).

Overview of Stabilization and Solidification process



Source: Nomura Kohsan Co., Ltd

Mercury Technology Bulletin Series:

Advantages/Strengths

Environmentally Sound Treatment

Majority of mercury in nature exists in the form of mercury sulfide (HgS) and hence this form of mercury is very stable with very little risk of volatilization and elution of mercury. Dissolution tests conducted on Mercury Sulfide produced using this method have shown mercury concentrations to be less than 0.005mg/L

Black Mercury Sulfide after stabilization

Photo provided by Nomura Kohsan Co., Ltd

Reliable method for Stabilization

Other methods of stabilization like Vapor-Phase synthesis method require sophisticated equipment and have a risk of leakage/release of mercury. Mechano-chemical method controls physical reaction of mercury and sulfur and does not use any chemical. It results in a low risk of leakage/release of mercury as mercury is not vaporized.

Solidified Sulfur Polymer

Photo provided by Nomura Kohsan Co., Ltd

Improved method of Solidification

Using sulfur for solidification produces a product that is of higher density, higher strength, higher salinity tolerance and higher acid resistivity than using traditional method of concrete solidification.

Applicability

The requirement of the degree to which excess mercury needs to be treated depends on the legal requirement as described in the standards or guidelines developed in each country. Countries that do not yet have legal stipulations need to develop guidelines , taking into account the country's existing environmental and safety laws and regulations.

The legal requirement will determine whether stabilization of mercury alone is sufficient , or whether a further step of solidification may be required after stabilization. Package units for stabilization of waste mercury that can be installed and used onsite is now under development. Export of these mobile units from Japan are planned which can then be set up in the countries where ESM of the waste mercury presents significant challenges.

Stabilization and Solidification plant

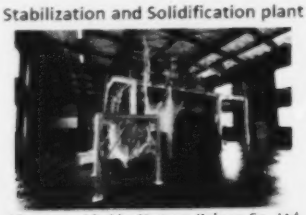
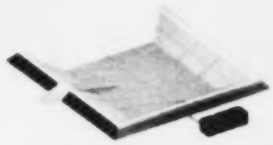


Photo provided by Nomura Kohsan Co., Ltd

Final storage in controlled landfills



Source: Nomura Kohsan Co., Ltd

Nomura Kohsan Co., Ltd, Development of Stabilization and Solidification Technology
(http://nkcl.jp/research/stabilization-solidification-processes/)

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Environmental Health Department
Ministry of the Environment, Japan
1-2-2 Kasumigaseki, Chiyoda-ku Tokyo, 100-8975, Japan
Tel: +81-(0)-3-5521-8260, E-Mail: suigin@env.go.jp
http://www.env.go.jp/en/chemi/mercury/mcm.html

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Ministry of the Environment

MINS

Mercury Technology Bulletin Series: 010

Monitoring of Mercury in Ambient Air

Background

Mercury is emitted to the atmosphere from both natural and anthropogenic sources. In order to make the necessary policy decisions and develop specific strategies for the reduction of anthropogenic emission of mercury from various sources, the information on the level of mercury in the ambient air is necessary. Article 19 of the Minamata Convention also calls on the Parties to endeavor to cooperate with each other and to develop and improve the monitoring of levels of mercury and its compounds.

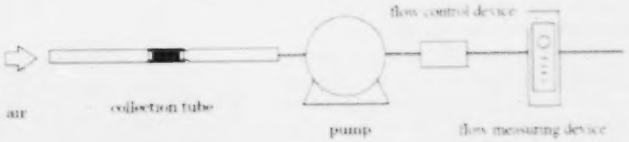
Japan has developed a reliable method for the measurement of mercury in the ambient air and published it as a part of the *"Manual of Measurement Method of Hazardous Air Pollutants"*. This manual will be a useful tool for countries to prepare a monitoring system for atmospheric mercury.

Overview of the Technology

The measurement method for mercury in the ambient air, as described in the *"Manual of Measurement Method of Hazardous Air Pollutants"* comprises of Gold Amalgamation Trap, Thermal Desorption and Cold Vapor Atomic Absorption Spectrometry.

Mercury in the ambient air is collected at a constant flow rate by using a collection tube (inner diameter 4mm) filled with mercury trap particles (80 mg of particles capped on both sides with quartz wool). The particles are composed of diatomaceous earth particles (thermostable earth particles of 500 – 600 μm in diameter) with gold bake-coated on their surfaces.

Overview of mercury sampling device

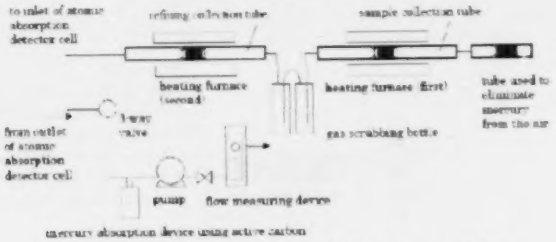


Source : Manual of measurement method of hazardous air pollutants

Generally, the flow rate of air sample collection is 0.5-1 mL per minute and sample is collected for 24 hours for ambient monitoring. As the flow rate is not very high, the collection of air sample can be done by a small pump. The necessary electrical power is also small.

During sampling, the surfaces of the particles may adsorb interfering gas other than mercury vapor that could compromise the measured values of mercury. The collected air sample tube is sealed and sent to the laboratory for measurement. On measurement of the CVAAS (Cold Vapor Atomic Absorption Spectrometry), in order to eliminate the influence of interfering gas, the collection tube is connected to a thermal desorption device whereby the generated mercury vapor is re-trapped by a refining collection tube. Then desorbed atomic mercury from secondary collection tube is led to the absorption detector cell of the atomic absorption spectrometer to determine the quantity of mercury by measuring the atomic absorption at a wavelength of 253.7nm. Measuring instruments specific to this type of collection tube are commercially available, but generic Atomic Absorption Spectrometer can be used for measurement by setting up the device to introduce mercury into the spectrometer from heater or pump.

Thermal Desorption Device


to inlet of atomic absorption detector cell
refining collection tube
sample collection tube
heating furnace (second)
heating furnace (first)
tube used to eliminate mercury from the air
3-way valve
from outlet of atomic absorption detector cell
gas scrubbing bottle
pump
flow measuring device
mercury absorption device using active carbon

Source : Manual of measurement method of hazardous air pollutants

Mercury Technology Bulletin Series:

Advantages/Strengths

Data accuracy

This method of measuring the concentration of mercury in the ambient air using Gold Amalgamation Trap, Thermal Desorption and Cold Vapor Atomic Absorption Spectrometry is the official method for atmospheric mercury monitoring in Japan.

It is a proven method commonly used in Japan and is widely considered to provide accurate and reliable data. If the clearly defined procedures for measurement are followed, very little difference in measured value, irrespective of which entity is carrying out the measurement, is observed. This ensures comparability of various different data sets obtained through measurement using this technique.

Decent tool for policy making and concrete action

Measurement of ambient air concentration of mercury can be a useful tool to help decision makers to formulate policies, and take concrete actions to protect the population from mercury exposure. The method can be used for formulation of monitoring system by policy makers. As the device used for sample collection is small and inexpensive, this method can be applied for the monitoring of local mercury usage and emission.

Example of sampling setup

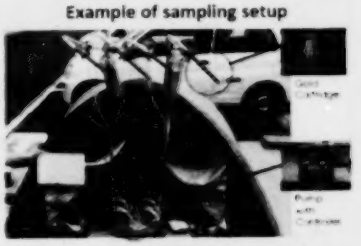


Photo provided by IDEA Consultants, Inc.

Applicability

With this method, analysis and collection of gaseous elemental mercury in the ambient air is possible. Measurement accuracy and sampling efficiency of the other chemical forms of mercury is partly uncertain. However, as the majority of mercury in ambient air exists as gaseous elemental form, the measured value determined by this method is considered as measured value for mercury concentration in the ambient air.

In order to ensure the reliability of the measured value, it is necessary to implement a strict measurement quality control. The Japanese government, through Japan International Cooperation Agency (JICA), has started a training programme since 2017 entitled "Capacity strengthening for multi-media mercury monitoring (4M) " aimed at laboratory technicians from developing countries on monitoring of mercury. The goal of this program is to enhance the capacity of analytical techniques and laboratory management necessary for more functional mercury monitoring.

Training of participants from developing countries

Further Reading

MOEJ, Manual of measurement method of hazardous air pollutants
- Monitoring of mercury in the Ambient Air (Japanese only)
(http://www.env.go.jp/air/osen/manual2/pdf/01_chpt6.pdf)

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Ministry of the Environment

2. Information submitted by Nigeria

CAPACITY BUILDING, TECHNICAL ASSISTANCE AND TECHNOLOGY TRANSFER

1. Capacity building programmes and Technical assistance in the following areas:

i. Establishment of a sustainable system for the collection, monitoring and interpreting data on mercury use, trade, emissions, releases and disposal.

ii. Customs and regulatory officials on the control of illegal import of mercury containing products into the country.

iii. Dental professionals and students in the use of mercury free dental restoration techniques and materials/Best management practices at dental clinics in the use of dental amalgam.

iv. Establishment of an environmentally sound system for the collection and interim storage facility for mercury-containing waste products.

v. Technical officers on mercury management, accessing financial opportunities for Sound Management of Chemicals and negotiation techniques to enhance their ability to implement and meet the country's obligations under the Convention.

vi. Institutionalization of safer mining programmes.

vii. Upgrading of identified laboratories for specialized chemical analysis including mercury.

viii. Study tours to mercury management facilities that meet the convention's requirements.

2. Technology transfer and Technical assistance are required in these areas:

a. BAT and BET for retrofitting of existing industries (point source of mercury) lacking the appropriate mercury pollution abatement technology.

b. Mercury free gold processing techniques for Artisanal Small Scale Gold miners.

c. Environmentally sound disposal of mercury and other hazardous waste.

3. Information submitted by the United States of America

In response to the request from the Committee of the Whole, the United States offers the following information related to capacity building and technical assistance as referred to in paragraph 4 and paragraph 5 of article 14 of the Minamata Convention.

The following are examples of capacity-building and technical Assistance Activities supported by the United States through funding or in-kind assistance. These U.S. supported activities have reduced the use of mercury in artisanal small-scale gold mining and other mining, including through introduction of mercury-free processing techniques; identified methods and technologies to reduce mercury emissions from coal combustion and store mercury safely; and provide individuals with tools to reduce their mercury exposure. The U.S. Department of State (DOS) Mercury Program website and the U.S. Environmental Protection Agency (EPA) International Cooperation website have brief project summaries. Additional information can be obtained by contacting Jane Dennison at DennisonJE@state.gov or Rodges Ankrah at ankrah.rodges@epa.gov.

Examples of Capacity-building and Technical Assistance Activities

Mercury emissions

- Reducing Mercury Emissions from the Coal Combustion Sector
  - DOS funded two International Energy Agency Clean Coal Center workshops to discuss methods and technology that countries could use to reduce mercury emissions from the coal combustion sector, one in India and one in South Africa.

- Measurement of Mercury and Black Carbon Emissions
  - DOS funded Arcadis, Inc. to build the capacity of Vietnam's government through training on analytical equipment to measure mercury emissions from the coal combustion sector.

- Mercury Emissions Measurement Toolkit
  - EPA developed a toolkit housing a complete portable package of sampling and analytical equipment to measure emissions from coal combustion sources such as power plants and cement manufacturing; successful testing in joint UNEP-EPA measurement efforts has occurred in South Africa, China and Russia.

- Mercury Emissions Control Demonstration at Russian Coal-Fired Power Plant
  - EPA, Russian Institutes, UNEP, and Sweden demonstrated that sorbents made from activated carbon removed up to 90 percent of mercury emissions at a Russian coal-fired power plant with particulate emission collectors.

- Information Exchange on Mercury Emission Sources
  - EPA provided information on mercury air pollution control and measurement to China related to metals smelting, cement production, and coal-fired power plants and industrial boilers.

Mercury Management

- Developing of National and Regional Approaches to Environmentally Sound Management of Mercury in Southeast Asia
  - DOS funded Ban Toxics and BaliFokus preliminary mercury intervention frameworks in Indonesia and the Philippines.

- Mercury Management, Storage, Stabilization and Disposal Action Planning in Peru
  - EPA assisted Peru's Ministry of the Environment in a multi-stakeholder, public-private workshop that outlined plans for enacting Peru's Minamata National Implementation Plan for storage and disposal of mercury.

- Developing Local Institutional Capacity to Collect, Manage and Store Mercury in Colombia
  - EPA is working with UNEP and the Colombian Cleaner Production Center (CNPML) to develop local capacities in ASGM and gold shop communities to manage and store excess mercury from ASGM mines and gold shops in Colombia. This is coordinated with local, regional and national government entities.

Artisanal small-scale gold mining (ASGM)

- Reducing ASGM Gold Shop Mercury Air Emissions and Human Exposure
  - EPA and the U.S. Department of Energy developed a system to capture mercury vapor emitted from amalgam burning in gold shops with 80% efficiency. Two systems were installed in Peru and Brazil. EPA provides technical assistance to Peru ASGM communities on issues related to burning amalgam.

- Developing Mercury Inventories in Artisanal and Small-scale Gold Mining in Southeast Asia
  - DOS funded a BaliFokus study on mercury inventories and trade in the ASGM sector in South East Asian countries involving Indonesia, Philippines, Vietnam, Singapore, Malaysia and several mercury-exporting countries.

- Reducing Mercury Use and Release in Artisanal and Small-Scale Gold Mining in Francophone West Africa
  - DOS supported the Artisanal Gold Council's work setting up three mercury-free processing plants that demonstrated a much higher recovery of gold than when miners were using mercury.

- Legal and Policy Approaches to Address Environmental and Health Impacts of Artisanal Gold Mining in Nigeria
  - DOS funded the Environmental Law Institute assessment of legal and policy challenges underpinning the informal artisanal and small-scale gold mining sector in Nigeria.

- Training and Educational Projects under the UNEP Partnership on Artisanal and Small-scale Gold Mining
    - DOS supported Natural Resources Defense Council mercury guide to help people reduce their exposures.

- Development and implementation of artisanal and small-scale gold miner training resources for reducing mercury use and release in South America
    - DOS supported the development of two training videos on mercury-free alternative processing techniques that can be introduced to ASGM operations.

- Environmental Enforcement and Mercury Detection in ASGM in Colombia
    - EPA and the US Department of Justice have provided training to Colombian law enforcement and environmental officials on mercury air and soil detection measurement equipment at ASGM sites.

- Prevention and Control of Gold Mining in Colombia and Peru
    - USAID, DOS and EPA are cooperating with Colombia and Peru to support formalization of the ASGM sector by developing transparent gold supply chains, improving working conditions and increasing control over the use, supply, management, storage and final disposition of mercury.

Collaboration to Achieve Policy Goals

- Information Exchange on Mercury
    - EPA facilitated the exchanged information on U.S. and Chinese policies for elemental mercury and mercury products relevant to the Minamata Convention through a bilateral workshop.

- UN Global Mercury Partnership (GMP)
    - The United States encourages participation in the UNEP's Global Mercury Partnership, in which the EPA plays an active leadership role, as a resource to Parties for advancing the management of mercury issues.

4. Information submitted by the International POPs Elimination Network (IPEN)

28/06/2018

a toxics-free future

IPEN combined submission to the Minamata Convention secretariat on;

- **mercury emissions resulting from the open burning of waste.**
- **capacity-building and technical assistance and technology transfer,**

Lee Bell
Mercury Policy Officer
IPEN
leebell@ipen.org

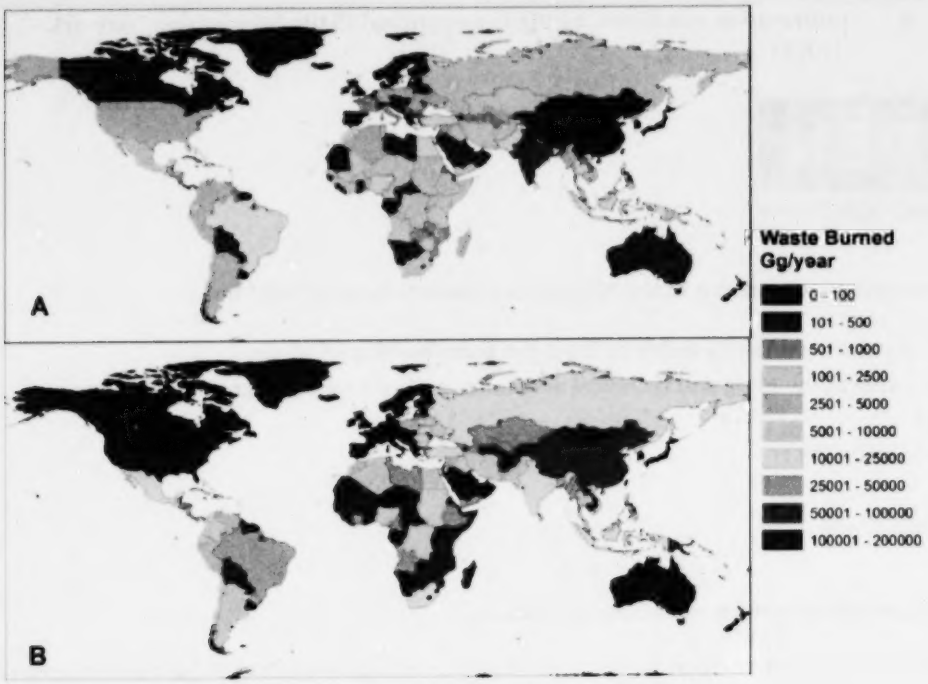
Mercury emissions from the open burning of waste.

In many developing countries (and in some developed countries) the practice of open burning of waste is practiced for a range of reasons including;

- volume reduction in the absence of a waste management/collection system;
- sanitation in the absence of a waste management/collection system;
- recovery of valuable metals from some waste streams (such as e-waste);
- mixed waste is too contaminated to recycle
- spontaneous or deliberately lit landfill fires.

This submission comments on the potential for capacity building and technology transfer to dramatically reduce the prevalence of open burning and the mercury emissions that result from it. Technology and capacity building should be extended beyond a narrow mercury focus to establish programmes that establish basic waste collection and separation systems that have an emphasis on separating organic and hazardous waste (highlighting mercury waste streams) from the recyclable waste stream. Synergies with funding, capacity building and technology transfer mechanisms of other chemical conventions should be explored as open burning is also a significant contributor of UPOPs such as PCDD/DF (Wiedinmyer et al 2014) and could be addressed in joint waste management projects based around collection and source separation to allow for recycling and treatment of discreet waste streams. Without basic source separation and collection systems mercury waste will continue to be a major contributor to anthropogenic mercury emissions from open burning.

Mercury can be liberated as vapor phase and particulate bound emissions from open burning waste fires leading to air, soil and water contamination as well as human health impacts. Waste containing mercury such as e-waste, medical waste and consumer products (CFLs, cosmetics, switches, thermometers) contribute to these emissions. It has been estimated that open burning of waste may contribute up to 10% of current anthropogenic emissions of mercury (Wiedinmyer et al 2014). A significant amount of open burning is situated in South Asia, south east Asia, Latin America and to a lesser extent, Africa (see fig 1). Open waste burning is also conducted in Pacific Islands.



i. Total estimated annual waste burned (Gg yr^{-1}) at the residential level (A) and at dumps (B).

Fig 1 Open burning estimates for residential and landfill mass. (source Wiedinmyer et al 2014)

A key response to open burning of waste which is leading to mercury emissions is the need to implement decentralised, economical waste management systems that maximise reuse and recycling of materials, separate hazardous materials for recycling or disposal and which directs organic wastes to value added processes while creating local employment opportunities.

Capacity building programmes for developing countries and countries with EIT to develop basic waste management systems based on collection and separation of material types is essential. Aid programmes often prioritise the construction of landfills and waste incinerators which sit at the bottom of the waste management hierarchy and are the least sustainable waste management and resource recovery options. They lead to ongoing groundwater contamination, UPOPs release and destruction of resources. Waste incineration is often proposed as a 'solution' to landfill and even as a better alternative to open burning as incineration allegedly takes place in 'controlled conditions'. However, the production of thousands of tonnes of toxic ash from incinerators requires additional landfill so the landfill problem is not in any sense 'solved'. Mercury waste management experts also contend that waste incineration is not appropriate for mercury contaminated or containing wastes as the risk of release of mercury vapors is high (Merly and Hube, 2014).

Fortunately, mercury waste is amenable to recovery despite its hazardous nature. If capacity building programmes can be directed at development of locally relevant, basic waste collection and sorting systems then hazardous components of the waste stream such as mercury bearing waste can be separated for treatment and recovery of mercury using technology that is readily available in developed countries and which is a fraction of the expense of establishing landfills or incinerators.

These technologies include fluorescent lamp and other mercury bearing lighting recycling, continuous distillation processes for mercury contaminated soils, mining wastes and sludges from the petrochemical and gas industries. Distillation technologies are already employed in the oil and gas sector to remove mercury from produced gas to protect gas storage systems from corrosion.

Technology transfer and capacity building that addresses the whole of the waste system in developing countries is important. The waste sector should be seen through the lens of the emerging circular economy and sustainable development goals. Instead of perceiving waste as a problem to be buried or burned it should be an opportunity to build small sustainable businesses in impoverished communities, generate local scale clean energy and employment while protecting human health and the environment.

Attention should be given to non-combustion waste management alternatives in terms of technology transfer. Waste management policy in the EU is moving away from incineration of waste and subsidies are being withdrawn in recognition that incineration is not compatible with the circular economy. Developing countries should be given the opportunity to 'leap-frog' polluting incineration and burial technology in the waste management sector and adopt cutting edge techniques to manage their waste through the capacity building and technology transfer processes.

A key aspect of this sustainable waste management process is source separation of organics. Organic waste is the main contributor to anaerobic conditions in landfill, leaching metals under reductive conditions into the groundwater and releasing large volumes of methane- a potent GHG. Organic waste also poses problems for incineration due to its high moisture content requiring supplemental fuel application (usually gas or oil) to reduce moisture levels. This leads to further emissions. Far more productive is the separation of organic materials from the waste stream and their use in anaerobic digestion (AD) and/or composting. The development of biogas from AD can be utilised for energy generation without the release of UPOPs and ash, a major problem suffered by waste incineration. The AD systems can be scaled up from basic household models through to school, commercial and fully industrialised models. Biogas from AD can also be used for cooking displacing more polluting cooking fuels. The final solid residue, digestate, is a valuable fertiliser for agricultural communities. There are clearly opportunities for technology transfer and capacity building programmes to address the waste systems of developing countries more holistically and the instruments of the Minamata Convention dedicated to these purposes (such as the Specific Trust Fund) could be applied. There is a clearly a need to use such mechanisms to address the uptake of AD in developing countries. Sub-Saharan Africa being a case in point where biogas could have enormous positive impacts but lacks seed funding and institutional understanding (Mwirigi et al 2014).

Once organics are removed from the waste stream other benefits are apparent. Organic wastes contaminate recycling in mixed waste systems. Their removal at the source separation stage increases the value of the recyclable component of the MSW stream which remains clean. Mixed waste and recyclables contaminated with organic materials has low value and is at higher risk of open burning. One sector of the recyclable components includes mercury impacts wastes.

A key source of mercury waste in municipal waste generation is compact fluorescent lighting (CFL) and associated fluorescent tubes. Once added to burning waste and broken the mercury phosphor powder escapes the glass lamp and can cause significant contamination and human exposure in vapor phase and as particulate.

Small-scale recycling facilities can be developed for CFL and tubes which contain the mercury-based powder, while separating glass, metal and plastic components for recycling. Many spent lamp recycling

collection systems are being established at point of sale to allow customers to return burned out lamps intact. These collected lamps can then be consolidated and sent to regional recycling facilities.

Figure 2. Fluorescent lamp recycling unit

These semi-automated units can recycle between 1 and 10 million lamps per year, are fitted with carbon filters and claim to limit mercury emissions to 0.001-0.002 mg/m^3. The outputs are separated mercury bearing phosphor power, glass cullet, and metal or plastic end caps.

Figure 3. CFL recycling unit fitted in Surabaya Indonesia 2013 and glass cullet from the process.

Locations that lack waste collection infrastructure may benefit from point of sale collection systems where clusters of recycling collection can take place for other hazardous and problematic wastes such as batteries and plastic. This helps to streamline the collection systems for the end recycling operation and is more convenient for the consumer resulting in higher collection rates.

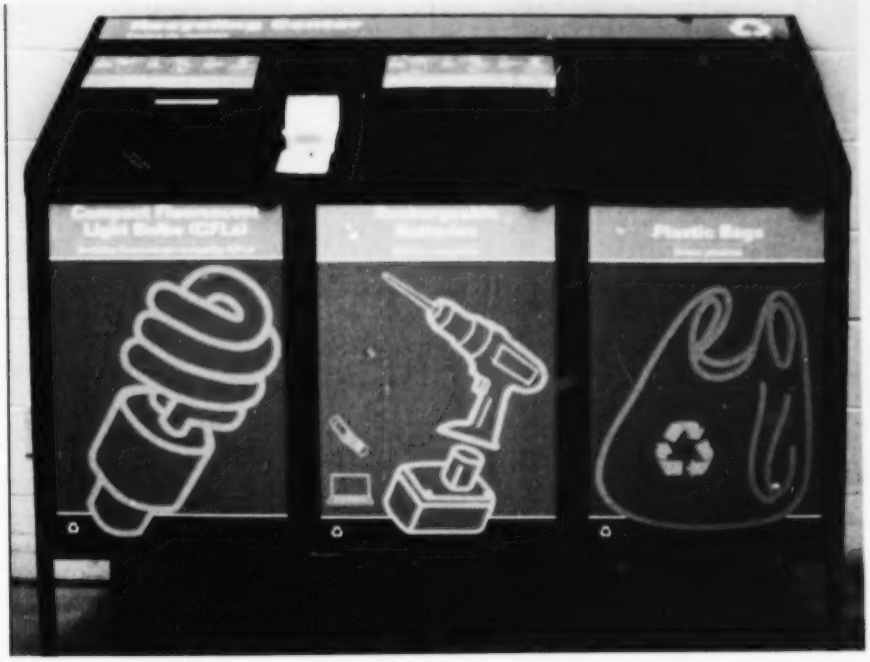


Figure 4. Collection points for fluorescent lamps using mercury can also be combined with collection points for other problematic wastes such as batteries and plastics.

Small scale recycling systems are only as effective as the collection system established for them as they may require significant volumes to remain profitable. National governments can consider extended producer responsibility schemes to help fund the establishment of these recycling operations. Poor disposal of CFL and mercury tube lamps is widespread in developing countries (Ecowaste Coalition, 2018) as represents a sector where successful recycling could be implemented economically based on commercialised technology.

Medical, dental, commercial, mining, oil/gas and industrial mercury waste.

These sources of mercury waste may also be included in open burning practices where waste collection infrastructure is absent. Technologies to extract mercury from these wastes and preventing them from entering the environment are readily available. Capacity building and technology transfer could see the implementation of regional, national and state mercury recovery centres in developing countries to manage these sources of mercury pollution.

Dental amalgam separators fitted in dental clinics where mercury amalgam is used can play a role in reducing mercury in the waste stream. However, eliminating mercury from dental therapy is a far more efficient solution which is clinically and economically feasible on a global scale. Many countries no longer use dental amalgam and the alternatives are well established and cost effective. However, for those dental practices that persist in using mercury separators are a significant barrier to environmental releases assuming that the waste they collect is managed in an environmentally sound manner. Mercury waste from dental amalgam separators can be processed for mercury recovery in the same way as industrial mercury waste through distillation and recovery methods.

Figure 5. Dental amalgam waste separator

Continuous distillation processes from recovering mercury from commercial, mining, oil/gas and industrial mercury waste are well established. However, under the article 11 of the Minamata Convention recovered mercury can still be marketed as a commodity for uses allowed under the convention. For uses where the mass balance of mercury inputs and waste can be potentially be contained by recovery technologies (e.g. CFL recycling) this may not present a large problem. However, if mercury recovery technology becomes widespread in developing countries the supply of this form of mercury could dramatically increase global supply. This is especially true of the mining and gas sectors where large volumes of mercury can be recovered from production gas and tailings.

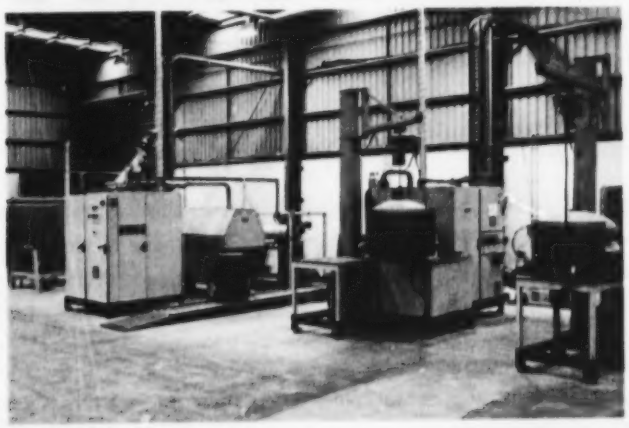


Figure 6. Continuous Flow Distillation plant for mercury extraction from waste

Careful thought need to be given to control mechanisms to restrict the supply of recovered mercury to the global market to prevent a proliferation of mercury supply. At the same time any restriction of sales of mercury by those operators of recovery systems may undermine the viability of their operation. It is clear

that if mercury produced through recovery operations is to be 'retired' from the commodity market then consideration needs to be given to purchasing mercury for retirement from recovery operations. A key consideration will be who should pay for mercury to be retired? For the mining, petroleum and gas sector there are clearly opportunities to implement polluter pays systems. For products containing mercury, the costs of retirement could be directed to manufacturers who choose to use mercury in production and processes. In any event if the twin policy aspirations or mercury recovery and permanent mercury retirement are to be achieved, then this issue will need to be resolved.

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5. Information submitted by the Zero Mercury Working Group (ZMWG)

ZMWG contribution in relation to Article 14 of the Minamata Convention, on capacity building, technical assistance and technology transfer

June 2018

In response to the request from the Committee of the Whole regarding the provisions under Article 14, addressing the matters of capacity building, technical assistance and technology transfer, the Zero Mercury Working Group is pleased to provide the following contributions based on some of its most recent projects:

1. *Contributing to the preparation/implementation of the Minamata Convention, with a focus on developing strategies to implement product phase–out provisions and national action plans for artisanal and small scale gold mining, in four African countries"* , July 2014-December 2017.

With funding provided by the European Commission (EC) through the Food and Agriculture Organization (FAO) of the United Nations, this project, reached a successful conclusion in December 2017, with encouraging, concrete and continuing results.

The project was managed by the European Environmental Bureau, in collaboration with the Zero Mercury Working Group (ZMWG), (hereafter referred to as EEB/ZMWG). Project partners were the Mercury Policy Project and Natural Resources Defense Council as resource organizations, groundwork South Africa as regional advisor, and SRADev-Nigeria, PANEM-Mauritius, Agenda-Tanzania and Friends of the Nation-Ghana as local partners.

The project focused on reducing mercury use in artisanal and small scale gold mining (ASGM) in Ghana and Tanzania through assisting in the development of National Action Plans (NAPs), and on mercury-added product phase-out in Mauritius and Nigeria. ASGM and products were chosen as thematic areas for the project because of the prominence of these mercury sources in the African Region. Globally ASGM accounts for 35% of anthropogenic airborne emissions of mercury, and mercury-added products represent the 3rd largest demand/consumption sector after ASGM and Vinyl Chloride Monomer production[1].

The project aimed to provide country stakeholders with a better understanding and direction on their overall Convention ratification and obligations via-a-vis the two project thematic areas. Overall, the project has been well-received by governments and has contributed to informing and solidifying relationships among the many stakeholders who are most likely to contribute to the successful implementation of the relevant Convention provisions. The project was welcomed as an integral part of wider national preparations for ratification and early implementation of the Convention. In particular, as a result of our project, important project activities continue and our local NGO partners are integral members of the project advisory committees (PACs), the national Steering Committees of the MIA projects in their respective countries, and are also part of the NAP development teams in Ghana and Tanzania.

On developing national strategies for phasing out mercury added products, the project:

[1] UNEP, Trade Report, p.10

- Engaged with the Ministry of the Environment, Mercury Focal Points and relevant stakeholders: Project Advisory Committees (PACs) involving relevant ministries/organisations, were constituted to inform and advise the project; a larger group of product related stakeholders were identified; and inception and final workshops were organised in both pilot countries.
- Assisted governments with drafting National roadmaps towards phasing out mercury added products: The project developed a ZMWG checklist and guide, including steps governments can follow to create a phase-out roadmap; the two pilot countries, Nigeria and Mauritius used the guide to draft their national roadmaps; the guide and checklist were presented at our regional workshop on products; and 29 African governments and Jamaica, plus over ten other Caribbean islands, have used the checklist and guide to develop their first draft roadmaps to phase out mercury added products.
- Further developed and implemented several of the steps identified in the checklist in the two pilot countries, specifically, the project produced:
    a. A study looking at the transition of the national market towards Convention compliant products;
    b. A legal gap analysis vis-à-vis the Article 4 requirements, in collaboration with the government of Mauritius ;
    c. Draft laws to meet Art. 4 requirements

A commitment was expressed by both countries to sustain efforts towards phasing out mercury added products through continuation of Product Advisory Committees and their work plans as well as furthering support for draft legislation to move forward to phase out products by 2020.

On the development of the ASGM National Action Plans (NAPs), the project:

- Conducted initial stakeholder outreach and consultation through two-day workshops to better inform stakeholders about the Minamata Convention and its requirements.
- Conducted research and created background documents profiling the status of the ASGM sector in Tanzania and Ghana.
- Conducted intensive consultations with mining communities where miners were informed about the Convention and its requirements, while simultaneously providing a platform where miners could provide their valuable input to structure the NAP.
- Created a step-by-step guide for conducting miner consultations that can be used for further engagement in the two pilot countries or by any other country developing a NAP.
- Developed recommendations for the NAP, based on the research and consultations, including: measures on formalisation; potential measures to discourage the most harmful ASGM practices and reduce mercury consumption and releases; and education and outreach to the mining communities.
- Provided training for NGO partners on Baseline Mercury Inventories from international mining experts, contributing to the local NGOs capacity building and ensuring their future contributions to the development of the NAPs.
- Built capacity of national small-scale mining associations through a series of workshops.

The lessons learned, experiences, deliverables and tools developed by the project were presented at two regional conferences held from the 22nd to 26th May, in Nairobi, Kenya, in collaboration with UN Environment. These conferences focused on phasing out mercury-added products and on reducing mercury use in ASGM. In total, over 70 representatives from 29 African governments and Jamaica, UN agencies, NGOs, academics, and private sector took part in the conferences.

Project partners participated actively at regional meetings, the sixth and seventh Intergovernmental Negotiating Committee meetings and in the First Conference of the Parties (COP1) for the Minamata Convention. They provided input to negotiations, interacted with stakeholders and governments, and presented the project results on different occasions. ZMWG members also attended and gave presentations during a series of eleven UNEP workshops around the world, to support ratification and early implementation of the Convention.

Overall, the project has also contributed to raising awareness about Convention obligations among various stakeholders, government agencies and officials, NGOs, traders, miners and other relevant parties. Three (Ghana, Mauritius, Nigeria) out of the four project countries have now ratified the Treaty.

2. *"Contributing towards early ratification and implementation of the Minamata Convention on Mercury and towards phasing out mercury added products."*

In 2016 three product phase out projects took place in Kenya (CEJAD), Ivory Coast (CASE) and South Africa (groundWork)[2]. In 2017, five additional projects[3] started in Kenya (CEJAD), and Ivory Coast (CASE) as well as in Bangladesh (ESDO), the Philippines (BanToxics!) and India (Toxics Link), under the title of: "Contributing towards early ratification and implementation of the Minamata Convention on Mercury and towards phasing out mercury added products." Building on the outcomes of the above mentioned project, these projects include fully or partly the following activities:

- Development and eventually assisting with the implementation of the checklist/roadmap to phase-our mercury added products with relevant government ministries.
- The development of study of availability of alternatives to mercury-added product of the country.
- Development/contribution on the legal gap analysis focusing on Article 4 provisions of the Treaty.
- Assisting hospitals to go mercury free with focus on phase out of thermometers and sphygmomanometers, in collaboration with the Ministry of Health.
- Sensitization of border inspectors from relevant government agencies and media on Minamata Convention/phase out provisions and illegal mercury containing products.
- Contribute to the global skin lightening product campaign
- Contribute to the MIA work

3. *"Towards quick Treaty Ratification, testing and phasing out mercury in dentistry and health care."*

In 2016, a project took place in Mauritius (PANEM)[4]. The project focused among others, on awareness raising, testing and phasing out mercury in dentistry and health care while engaging in their MIA, in support of quick Treaty Ratification. The EEB/ZMWG Lumex testing instrument was used to measure mercury levels in indoor air in a public hospital, 8 private clinics, 5 schools/colleges, a national laboratory , 3 jewellery shops and outside in 2 landfils and a CFL

[2] The project in South Africa was funded by German Ministry of Environment. The ones in Kenya and Ivory coast were funded by the Swedish International Development Agency (SIDA), via the Swedish Society for Nature Conservation (SSNC), through the European Environmental Bureau

[3] The projects are funded by the Swedish International Development Agency (SIDA), via the Swedish Society for Nature Conservation (SSNC), through the European Environmental Bureau

[4] The project was funded by the Swedish International Development Agency (SIDA), via the Swedish Society for Nature Conservation (SSNC), through the European Environmental Bureau

recycling company. Eighteen awareness raising meetings/activities were held, with positive feedback from the participants. PANEM has also been an active participant of the National Mercury focus group in Mauritius, and has followed closely the multiple government processes related to the Convention, from the Minamata Initial Assessment to supporting the ratification process.

Over the last two years[5], the EEB/ZMWG has place a considerable amount of effort into developing the capacity of its NGO partners, including but not limited to those mentioned above. Through the projects described, these NGOs have become key stakeholders and resources in their respective countries. In order to expand these efforts further, additional funding for NGOs that would allow continued support in the form of technical assistance, capacity building and technology transfer, is essential to the effective implementation of the Minamata Convention.

[5] EEB ZMWG has been funding around 5 projects per year since 2005, in around 30 countries. http://www.zeromercury.org/index.php?option=com_content&view=article&id=52&Itemid=41

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Item 5 (l) of the provisional agenda*

Matters for consideration or action by the Conference of the Parties: emissions of mercury resulting from the open burning of waste

Compilation of information submitted in relation to emissions of mercury resulting from the open burning of waste

Note by the secretariat

As referred to in the note by the secretariat on the matter (UNEP/MC/COP.2/16), a compilation of submissions from parties and other stakeholders on mercury emissions resulting from the open burning of waste is set out in the annex to the present note. The submissions are reproduced as received, without formal editing.

* UNEP/MC/COP.2/1.

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Annex

Compilation of information submitted in relation to emissions of mercury resulting from the open burning of waste

1. Information submitted by the Republic of Moldova

Ministry of Agriculture, Regional Development and Environment of the Republic of Moldova

MERCURY RELEASES FROM OPEN BURNING IN THE REPUBLIC OF MOLDOVA

2018

LEVEL 2

This calculation of releases was performed in accordance with UNEP's "Toolkit for identification and quantification of mercury releases", Inventory Level 2 (version 1.03, April 2015).

Table of Contents

1.	**Executive summary**	**4**
2.	**Data and inventory on waste incineration and burning**	**5**
2.1	Incineration of municipal/general waste	5
2.2	Open burning of hazardous waste	5
2.2	Incineration of medical waste	8
2.3	Incineration of sewage sludge	12
2.4	Open fire waste burning (on landfills and informally)	12
	References	**17**

1 Summary

The inventory of sources of mercury releases in the Republic of Moldova conducted in 2014 reference year 2014 based on UNEP Toolkit Level 2 (version April 2015). The inventory has been elaborated by the Environmental Pollution Prevention Office within the Ministry of Environment of the Republic of Moldova (EPPO) in the frames of the project *UNEP GEF Project "Enabling activity development of Minamata initial assessment in the Republic of Moldova"* revealed that the **main source categories present in country** are:

i) Extraction and use of fuels energy sources
ii) Production of other minerals and materials with mercury impurities
iii) Consumer products with intentional use of mercury
iv) Other intentional products process uses.
v) Production of recycled metals.
vi) Waste incineration and waste burning
vi) Waste deposition landfilling and waste water treatment.
vii) Cremation and cemeteries.

An aggregated presentation of the results for the category open burning of waste is presented in Table 1.1 below.

Table 1-1 Summary of mercury releases from open burning of waste for the period 2012-2016, kg/year

Source category: Waste incineration	**2012**	**2013**	**2014**	**2015**	**2016**
Incineration of municipal general waste	0.000	0.000	0.000	0.000	0.000
Incineration of hazardous waste	0.164	0.168	0.181	0.145	0.175
Incineration of medical waste	5.922	5.910	5.614	5.333	5.066
Sewage sludge incineration	0.000	0.000	0.000	0.000	0.000
Informal waste burning (open fire waste burning on landfills and informally)	49.152	49.086	48.987	48.528	47.996
Total	**55.238**	**55.163**	**54.782**	**54.006**	**53.237**

In 2016, the waste open burning sub-category contributing with the highest **mercury releases to the atmosphere** is the informal waste burning with 47.99 Kg Hg y, that represents 90% of mercury releases from the source category *5.S Waste incineration and burning, followed by open burning of medical waste.*

Figure 1. Releases of mercury from open burning of waste, 2012-2016, kg/year

2. Data and inventory on waste incineration and burning

2.1 Incineration of municipal/general waste

In the Republic of Moldova, there are no authorized facilities for incineration of municipal general waste. For this reason, emissions of mercury from this sub-category were not estimated.

2.2 Open burning of hazardous waste

Subcategory description

Hazardous waste refers to residues and wastes which contain hazardous materials in significant quantities. Generally spoken, all materials including consumer goods, which require special precautions and restrictions during handling and use, belong to this group. These include solvents and other volatile hydrocarbons, paints and dyes, chemicals including pesticides and herbicides, pharmaceutical products, batteries, fuels, oils and other lubricants, as well as goods containing heavy metals. Also, all materials contaminated with these materials such as soaked rags or paper, treated wood, production residues, etc., are considered hazardous waste (UNEP, 2003).

Methodology applied to estimate releases from open burning of hazardous waste

The formula used for calculation of mercury emissions to different media is:

Estimated mercury release to pathway Y = **activity rate × input factor × output distribution factor for pathway Y**

Source: UNEP, 2015

Activity rate data

The activity rate data needed to estimate releases from open burning of hazardous waste in the Republic of Moldova is the amount of hazardous waste burnt annually.

For this sub-category the releases has been assesses for one waste flow – used vehicle oil, which is informally burned in auto service centers for heat production purposes and thus, can be considered as open burning. An estimate of the potential quantity of waste oil generated by transport in Moldova in the period 2012-2016 in presented in the table 2-1. The source of data is the official reply provided by the Customs Service of the Republic of Moldova (letter no 28-07-3590 as of 14.03.2017).

It is assumed that 90 % of the generated waste oil is burnt by the service centers.

Table 2-1 Activity rate data used to estimate releases from incineration of hazardous waste – waste oil, tones

Customs code	2012	2013	2014	2015	2016
2710198l0	5911.281	6255.602	6601.358	6101.920	6557.095
2710199l0	474.812	529.551	756.963	486.789	421.500
2710198l0	631.809	687.564	691.038	778.616	831.513
2710198l0	481.254	546.979	594.339	760.027	712.342
2710199l0	137.356	81.758	98.228	60.562	61.456
2709009l0	75.178	677.074	298.218	52.019	
2710199l0			30.728		

271019850	25.328		20.073	29.816	
271011900	50.350	459.210	554.618		
271019310					
271019250				8.715	
271019650					
271019610	503.461	23.120			
271019290	0.386		0.147	2.033	
271019110					
271099000	0.009			0.087	
271019150	0.105				
271011250	1041.474		939.640		
271011210	163.820				
271019910	44.725	44.733		18.940	19.295
270750900	41.900				
270799990		0.106		1.568	1.697
270900100		504.880			
271012210				152.796	154.956
271020900				0.900	
271012900				0.509	6.080
271012110				0.046	
271012250					1469.343
270730100					0.510
271012150					0.024
Total placed on market	**9583,248**	**9810,577**	**10585,35**	**8455,343**	**10235,811**
Total waste oil generated	**9104,0856**	**9320,048**	**10056,082**	**8032,575**	**9724,0204**
Total burnt	**8193,67704**	**8388,043**	**9050,4742**	**7229,318**	**8751,6184**

Mercury input factor

In order to estimate emissions of mercury from the sub-category Incineration of hazardous waste, information on the concentration of mercury in the processed hazardous waste is needed. Since the type of hazardous waste identified to be burned in the country is vehicle used oil, which represents a mix of synthetic and mineral lubricants, it was considered appropriate to use as input factor for this sub-category the concentration of mercury offered in the Toolkit as default input factor for heavy oils, namely 0.02 g Hg per ton of oil incinerated. For a more accurate estimate, actual results of mercury content analysis of the used oil would be required. However, at this point of the inventory, such data has not been identified within the company or sought independently by the project team.

Output distribution factors

For the calculation of mercury emissions based on IL2 approach the default output distribution factors that have been already provided in the IL2 Excel calculation spreadsheet were used.

Summary of inputs and results

Table 2-2 Summary of inputs and results from sub-category 5.8.2 Incineration of hazardous waste in the Republic of Moldova in 2012-2014

Incineration of hazardous waste	Unit	Production	Use	Disposal (open burning)				
				2012	2013	2014	2015	2016
Activity rate	Used oil open burnt, t/y	-	-	8193.6	8388.0	9050.4	7229.3	8751.6
Input factor for phase	g Hg/t waste oil burnt	-	-	0.02	0.02	0.02	0.02	0.02
Calculated input to phase	kg Hg/y	-	-	0.1638	0.1677	0.1810	0.1445	0.1750
Output distribution factors for phase:	fraction		-					
- Air	-	-	-	1	1	1	1	1
- Water	-	-	-	-	-	-	-	-
- Land	-	-	-	-	-	-	-	-
- Products	-	-	-	-	-	-	-	-
- General waste treatment	-	-	-	-	-	-	-	-
- Sector specific waste treatment	-	-	-	-	-	-	-	-
Calculated outputs/releases to:			-	-	-	-	-	-
- Air	kg Hg/y	-	-	0.1638	0.1677	0.1810	0.1445	0.1750
- Water	kg Hg/y	-	-	-	-	-	-	-
- Land	kg Hg/y	-	-	-	-	-	-	-
- Products	kg Hg/y	-	-	-	-	-	-	-
- General waste treatment	kg Hg/y	-	-	-	-	-	-	-
- Sector specific waste treatment	kg Hg/y	-	-	-	-	-	-	-

Data gaps and priorities for potential follow up

Due to the lack of authorized hazardous waste treatment facility/ incinerator and lack of statistic data on open burning of waste oil, the quantity of waste oil was estimated on the basis of expert judgement.

Because an analysis of the used oils for mercury content has not been carried out by the company or other specialized institutions, it is highly uncertain that the default input factor used in the IL2 calculation spreadsheet is appropriate for use in the calculation of mercury emissions from this subcategory. It is probable that concentration of mercury in used vehicle oil is different than the one in the initial oil used as lubricant in vehicles.

It should be noted that, according to the Waste Act no. 209 of July 29, 2016, which entered into force on January 23, 2017, all economic operators carrying out dangerous waste management activities are to be authorized to carry out their activity on the basis of the new requirements stipulated in the said law. Until now, no economic agent has obtained authorization for the collection and management of used oil.

At the same time, Article 12 of the Waste Act contains provisions related to the extended responsibility of the producers of products. The article provides that natural and legal persons designing, producing, processing, treating, selling and / or importing products are subject to extended producer responsibility in order to enforce reuse and prevention, recycling and other forms of waste recovery. In order to promote the principle of extended producer responsibility, the following products will be subject to these regulations:

- batteries and accumulators;
- electrical and electronic equipment;
- vehicles;
- *oils*;
- packaging.

2.2 Incineration of medical waste

Subcategory description

Medical waste includes infectious and non-infectious wastes generated by a variety of facilities engaged in medical care, veterinary care, or research activities such as hospitals, clinics, doctors' and dentists' offices, nursing homes, veterinary clinics and hospitals, medical laboratories, and medical and veterinary schools and research units. The mercury content in the medical waste stream originates primarily from intentionally used mercury in discarded products and process waste. The mercury concentrations are directly dependent on the inputs of mercury to the waste (UNEP, 2015).

Medical waste is considered to be every waste generated from medical activities regardless if these activities take place in a hospital or are performed by a medical doctor, dentist or any other physician. The waste generated during these activities includes secretes, blood, pharmaceuticals and packaging materials and or tools used for the medical treatment of people or animals. To reliably destroy viruses, bacteria, and pathogens this waste is often thermally treated by incineration (UNEP, 2003).

Methodology applied to estimate releases from incineration of medical waste

The formula used for calculation of mercury emissions to different media is:

Estimated mercury release to pathway Y = **activity rate × input factor × output distribution factor for pathway Y**

Source: UNEP, 2013

Activity rate data

The activity rate data needed to estimate releases from incineration of medical waste in the Republic of Moldova is the amount of medical waste incinerated/ burnt annually.

In the Republic of Moldova, there are no authorized medical waste incinerators.

However, it is common practice that medical waste is burnt at the medical institutions and hospitals in order to destroy infectious waste. The practice of medical waste burning is carried out mainly through three methods: 1) open burning, 2) closed burning in boilers for heating or metal barrels and 3) transportation for treatment through pyrolysis by a specialized authorized company[1].

The total amount of medical waste burnt in the public health institutions in the country has been summarized on the basis of data presented by the National Public Health Centre[2] and is presented in the Table 2-3 below.

Table 2-3 Estimated amounts of medical waste treated by thermal methods from public medical institutions in Republic of Moldova for the period 2012-2016

	2012	2013	2014	2015	2016
Amount of medical waste burnt, tones	740,3	738,7	701,7	666,62	633,289

Mercury input factor

Available information indicates that medical waste incineration systems can be significant sources of mercury emissions. Mercury emissions result from mercury-bearing materials contained in the waste. Known mercury sources include thermometers, blood pressure gauges, dental material with mercury amalgam, batteries, laboratory chemicals (in tissue samples etc.), fluorescent lamps, high-intensity discharge lamps (mercury vapour, metal halide, and high-pressure sodium); special paper and film coatings, and pigments; most of which should preferably be sorted out the waste stream before incineration, if possible (UNEP, 2015).

The type of medical waste burnt within medical institutions in the country constitutes largely infectious (pathological) waste, such as syringes and post-operational waste. Mercury-bearing materials mentioned above such as mercury thermometers, fluorescent lamps and high-intensity discharge lamps are usually collected and stored separately within the institutions. Dental material with mercury amalgam is not used in the country, therefore it is estimated as not being present in the produced medical waste.

The mercury content in the medical waste determines the mercury inputs to incineration of medical waste. However, as presented above, the medical waste burned by medical institutions in the Republic of Moldova is composed of infectious waste, which is free of mercury containing products. Information received from medical institutions in the country confirmed that the type of medical waste burned includes infectious waste.

Analysis of mercury in infectious waste burned in the country has not been carried out up to date, therefore in order to determine potential concentration of mercury in medical waste burned, results of studies of mercury emissions from incineration of medical waste carried out in other countries could be used. Results of an USA study that looked at mercury emissions from incineration of pathological waste and general medical waste can be considered relevant for establishing possible mercury concentration in medical waste burned in the Republic of Moldova. According to the data obtained in this study, an average atmospheric emission of 8.9 g Hg per metric ton of incinerated pathological and general medical waste was

[1] Trisumg Ltd treats certain plastic medical waste through pyrolysis

[2] Letter no. 06t-3-2524 of 30.10.2015 from the National Public Health Centre

produced in the USA in 1996 (US EPA. 1997b cited in UNEP. 2015). Also, it was established that pathological waste contain significantly less than mercury than general medical waste, which on average contain about 8.2 g mercury per metric ton (US EPA. 2004 cited in UNEP. 2015).

Based on above data, it can be deduced that infectious medical waste could contain up to 8 g of mercury per metric ton. Additionally, the UNEP Toolkit methodology indicates that the low end input factor (8 g Hg metric ton waste) is expected to be relevant for a situation where substantial parts of the waste products with high mercury concentration (thermometers, batteries, dental amalgam wastes, fluorescent lamps etc.) have been sorted out of the waste for separate treatment, and will therefore be present in lower amounts in the waste (UNEP. 2015). Taking into consideration this information, in the case of the Republic of Moldova it was deemed appropriate to choose the low end default input factor of 8 g Hg t of incinerated waste, which was used for the quantification of mercury releases from this sub-category.

The incineration technology and particularly the flue gas cleaning systems applied, determine the distribution of the output of mercury between air emissions and releases to water (UNEP. 2013). According to the data presented by the National Public Health Centres across the country, in the Republic of Moldova, medical waste is burnt either openly or in furnaces of the local medical institutions. Therefore, no emission reduction devices are applied; hence for the quantification of releases from this sub-category *Output Scenario 1) No emission reduction devices* has been chosen.

Output distribution factors

For the calculation of mercury emissions, the default output distribution factors already provided in the IL2 Excel calculation spreadsheet have been used.

Mercury inputs and results

Table 2-4 Summary of inputs and results from sub-category Incineration of medical waste in the Republic of Moldova in 2012-2016

Incineration of medical waste	Unit	Production	Use	Disposal (open burning)				
				2012	2013	2014	2015	2016
Activity rate	t medical waste y	-	-	740.3	738.7	701.7	666.62	633.289
Input factor for phase	g Hg t medical waste	-	-	8	8	8	8	8
Calculated input to phase	kg Hg y	-	-	5.922	5.910	5.614	5.333	5.066
Output distribution factors for phase:	fraction		-					
- Air	-	-	-	1	1	1	1	1
- Water	-	-	-	-	-	-	-	-
- Land	-	-	-	-	-	-	-	-
- Products	-	-	-	-	-	-	-	-
- General waste treatment	-	-	-	-	-	-	-	-
- Sector specific waste treatment	-	-	-	-	-	-	-	-
Calculated outputs/releases to:			-	-	-	-	-	-
- Air	kg Hg y	-	-	5.922	5.910	5.614	5.333	5.066
- Water	kg Hg y	-	-	-	-	-	-	-
- Land	kg Hg y	-	-	-	-	-	-	-
- Products	kg Hg y	-	-	-	-	-	-	-
- General waste treatment	kg Hg y	-	-	-	-	-	-	-
- Sector specific waste treatment	kg Hg y	-	-	-	-	-	-	-

Data gaps and priorities for potential follow up

The full data on amounts of waste formed in private hospitals, clinics, doctors' and dentists' offices that activate in the country is missing. Additionally, an in-depth assessment of mercury contents in medical waste is needed.

2.3 Incineration of sewage sludge

In Republic of Moldova, the practice of sewage sludge incineration is not present. For this reason, emissions of mercury from this sub-category are not estimated and presented.

2.4 Open fire waste burning (on landfills and informally)

Subcategory description

Informal waste incineration is defined as waste incineration undertaken at informal conditions, in barrels, containers, or on bare land, with no flue gas controls and diffuse spreading of incineration residues on land. Open burning of waste at landfills – often applied to reduce waste amounts - also belong to this subcategory. The mercury present in the waste, part of it will be released to air, and part of it will remain in incineration residues (including unburned and semi-degraded waste) with a potential for additional subsequent mercury releases to air, ground water and surface waters. Given the volatility of mercury, it is expected that most of the mercury is released into the air as a result of informal waste incineration. This waste disposal method may pose an immediate risk for the local community in which it takes place, because air emissions (of several potent pollutants) are not controlled and residues may cause contamination of the local ground water (UNEP, 2015).

Methodology applied to estimate releases from open fire waste burning

If open fire waste burning is a widespread waste disposal method in the country examined, the potential mercury releases can be indicated through 1) quantification of mercury inputs with individual products and, or 2) by applying the mercury input default factors (mercury concentrations in municipal waste), in combination with rough estimates of amounts of waste incinerated informally per year. The resulting estimates are of course very uncertain, but may give a rough indication of the order of magnitude of mercury releases from informal waste incineration (UNEP, 2015).

The approach chosen to estimate potential mercury releases from open-burning of general waste is to apply the mercury input default factors for II.2, in combination with rough estimates of amounts of waste incinerated informally per year.

The formula used for calculation of mercury emissions to different media is:

Estimated mercury release to pathway Y = **activity rate × input factor × output distribution factor for pathway Y**

Source: UNEP, 2015

Activity rate data

The activity rate data needed to estimate releases from open fire waste burning in the Republic of Moldova is the amount of waste burned informally per year.

The amount of waste burned informally per year has been estimated by using the equation suggested for calculation of the amount of municipal solid waste open-burned in the IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 5section 5.3.2 (2006).

The equation used is the following:

$$MSW_B = P * P_{frac} * MSW_P * B_{frac} * 365 * 10^{-3}$$

Where:
MSW_B = Total amount of municipal solid waste open-burned, t/yr
P = population (capita)
P_{frac} = fraction of population burning waste, (fraction)
MSW_P = per capita waste generation, kg waste capita day
B_{frac} = fraction of the waste amount that is burned relative to the total amount of waste treated, (fraction)
365 = number of days by year
10^{-3} = conversion factor from kilogram to ton.

The data necessary for calculating the amount of waste open burnt is presented in the table below.

Table 2-5. The estimated quantity of municipal waste open burned

	2012	2013	2014	2015	2016
Urban per capita waste generation, kg waste capita day	0.9	0.9	0.9	0.9	0.9
Rural per capita waste generation, kg waste capita day	0.5	0.5	0.5	0.5	0.5
Population urban	1721.4	1728.2	1732.5	1726.1	1711.4
Population rural	2204.6	2195.5	2185.8	2158.7	2132.2
Population total	3926	3923.7	3918.4	3884.8	3843.6
MSW incinerated urban, kt	16.964	17.032	17.074	17.011	16.866
MSW incinerated rural, kt	32.187	32.054	31.913	31.517	31.13
MSW incinerated total, kt	49.152	49.086	48.987	48.528	47.996

According to the 2006 IPCC Guidelines, open burning includes regularly burning and sporadically burning. Regularly burning means that this is the only practice used to eliminate waste. Sporadically burning means that this practice is used in addition to other practices and therefore open burning is not the only practice used to eliminate waste. For countries that have well-functioning waste collection systems in place, it is good practice to investigate whether any fossil carbon is open-burned. In a developed country, P_{frac} can be assumed to be the rural population for a rough estimate. In a region where urban population exceeds 80 per cent of total population, one can assume no open burning of waste occurs. In a developing country, mainly in urban areas, P_{frac} can be roughly estimated as being the sum of population whose waste is not collected by collection structures and population whose waste is collected and disposed in open dumps that are burned.

The incineration of waste practice is predominantly characteristic to rural areas, both in households and on landfills in order to reduce the volume of solid waste disposed, mainly by burning organic waste (paper, cardboard, plastics and vegetable waste).
It is worth mentioning that specialized waste collection and disposal services exist in the municipalities of the country as well as in the district centres, but this system covers only about 60-80 per cent of the total urban population generating solid municipal waste. Therefore, the share of the population that does not benefit from waste collection services is about 10-30 per cent, or on average about 20 per cent. In the absence of official data on per capita waste generation, it was used the value of 0.5 kg/capita/day for rural population, respectively 0.9 kg/capita/day for the urban population of the Republic of Moldova.

It was considered that circa 20 per cent of the urban population that does not benefit from waste disposal services uses to burn in open-air the organogenic solid waste, while the fraction for solid waste burned (B_{frac}) from the total amount of treated waste in urban areas represents 0.15 (15 per cent of the total). In rural areas, it was considered that 40 per cent of the population uses to burn in openair the organogenic solid waste, and the B_{frac} represents 0.2 (20 per cent of the total).

Mercury input factor

UNEP recommends a input factor of 1 g Hg / tonne of waste where the significant amounts of waste with increased concentration of mercury (thermometers, batteries, dental amalgam wastes, switches etc.) selected from the waste that is generated to be treated separately and, therefore, are present in the municipal waste in smaller quantities, and a factor of 10 g Hg / t of waste where such a selection is not taking place and the much of the waste products with increased concentrations of mercury are present in municipal waste.

Possible mercury concentration in municipal solid waste disposed of in the Republic of Moldova can be inferred on the basis of available statistical data on imports of mercury containing products , such as fluorescent lamps, thermometers and batteries with mercury and appropriate input factors for each product category (see section on consumer products with intentional use of mercury). Estimated amount of mercury to be released in Moldova with mercury-added products in 2014 is shown in the Table 2-6 below. Using statistics on the total amount of waste transported to controlled landfills and the assumption that most mercury containing products are shipped along general waste to these landfills, the calculation is done based on the average concentration of mercury possible per tonne of waste from controlled landfills.

Table 26. Estimated amount of mercury to be released in Moldova with mercury-added products in 2014

Consumer products with intentional use of mercury	**Estimated quantity of mercury at disposal stage in 2014, kg/year**
Thermometers with mercury	195 kg
Electrical switches and relays with mercury	81 kg
Light sources with mercury	33 kg
Batteries containing mercury	21 kg
Polyurethane with mercury catalysts	65.5 kg
	Total: 395.5 kg/year

The table 2-6 below provides an estimate of the concentration of mercury in a tonne of general waste, considering that all imported products are discarded annually. Given the total incomings of mercury calculated for these products (395.5 kg Hg / year) compared to the total amount of municipal solid waste transported to controlled landfills in Moldova, including ATULBD (1.32568 million tons), it was estimated that 1 tonne of waste collected and transported to dumps containing less than 1 g of mercury (0.3 g / Hg). As the result given

calculations are based on estimates, the default factor concentration used for calculations in this report is 1 g Hg / tonne waste, as recommended by UNEP Toolkit.

Table 2-7 Estimation of the concentration of mercury in a tonne of municipal waste, considering that all imported products are removed annually

The total amount of municipal solid waste transported to landfills controlled in Moldova, including AUTLBD, 2014	1 325 680 tonnes
Estimation of total amount of mercury removed with mercury containing products for 2014	395.5 kg Hg
The average concentration of mercury calculated per ton of waste	395 500 g Hg/ 1 325 680 tonnes waste = 0.3 g Hg/tonne of waste

Output distribution factors

For the calculation of mercury emissions the default output distribution factors that are provided in the IL2 Excel calculation spreadsheet have been used.

Data gaps and priorities for potential follow up

No major data gaps were revealed within this category. The assumptions made with regard to the practice of informal waste burning for the population living on the left side of Dniestr River have been made based solely on the data available for the population from the right bank of Dniestr River.

Summary of inputs and results

Table 2-8 Summary of inputs and results from sub-category Informal burning of waste in the Republic of Moldova in 2014

Open burning of municipal waste	Unit	Production	Use	Disposal (open burning)				
				2012	2013	2014	2015	2016
Activity rate	t municipal waste y	-	-	49152	49086	48987	48528	47996
Input factor for phase	g Hg t municipal waste	-	-	1	1	1	1	1
Calculated input to phase	kg Hg y	-	-	49.15	49.09	48.98	48.52	47.99
Output distribution factors for phase:	fraction		-					
- Air	-	-	-	1	1	1	1	1
- Water	-	-	-	-	-	-	-	-
- Land	-	-	-	-	-	-	-	-
- Products	-	-	-	-	-	-	-	-
- General waste treatment	-	-	-	-	-	-	-	-
- Sector specific waste treatment	-	-	-	-	-	-	-	-
Calculated outputs/releases to:			-	-	-	-	-	-
- Air	kg Hg y	-	-	49.15	49.09	48.98	48.52	47.99
- Water	kg Hg y	-	-	-	-	-	-	-
- Land	kg Hg y	-	-	-	-	-	-	-
- Products	kg Hg y	-	-	-	-	-	-	-
- General waste treatment	kg Hg y	-	-	-	-	-	-	-
- Sector specific waste treatment	kg Hg y	-	-	-	-	-	-	-

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2. Information submitted by Nigeria

Mercury emissions resulting from the open burning of waste.

The inventory of mercury emissions and releases using the UNEP Toolkit Inventory Level 2 (2017) shows that mercury emissions from informal waste burning is 10,900Kg Hg.

3. Information submitted by the United Nations Institute for Training and Research (UNITAR)

unitar
United Nations Institute for Training and Research

Mercury emissions from open burning of waste — Geneva, 29 June 2018

Dear colleagues at the Minamata Convention Secretariat,
As part of the follow up from the first meeting of the Conference of the Parties to the Minamata Convention, UNITAR would hereby like to contribute with our observations regarding emissions from open burning of waste in our work with the Minamata Initial Assessments in many countries, as well as our work with waste in developing the UN Environment Mercury Inventory Toolkit.

As conveyed in the plenary at COP1, UNITAR has observed in its inventory assistance to many countries that open burning of waste is among the major mercury emissions sources, especially in countries with no non-ferrous mining activities or coal-fired power plants.

As the open burning issue will likely, among others, be investigated through the results from the national mercury inventories conducted with the methodology of the UN Environment Toolkit, we would like to bring the following to your attention:

The Toolkit works with two different approaches to quantifying mercury flows to waste treatment. One that is based on the estimated output of mercury from products and processes (is often under-estimated due to lack of data in developing countries), and the other one which works with input factors for mercury concentrations in relevant waste types, including municipal waste. In the general mode of using the Toolkit, it is the latter approach that is used for estimation of mercury emissions from open waste burning.

The input factor of the latter approach for municipal waste was at the time of the creation of the Toolkit based solely on data from developed countries, as no data from developing countries were available at that time (2004). The factor was set at 1-10 g/t waste, with a conservatively set intermediate value of 5g/t, considering that on-going substitution of mercury-added products in developed countries would be ahead of the substitution in developing countries, where the cheaper mercury-added products were still not regulated and the mercury-free alternatives were generally not in demand, and where segregation of mercury-containing waste was not practiced.

UNITAR is currently conducting an update for UN Environment of the Toolkit, expected to be finalised by the end of 2018. Preliminary collection of data in spring 2018 on mercury concentrations in municipal waste in developing countries for this work, supported by data from UN Environment's work on open waste burning (Honda et al., 2018), and from the Global Mercury Assessment work (Kindbom et al., 2018), indicate that the average mercury concentrations in the developing countries from which data on this subject have been published (mainly China, and a bit on Thailand and India) may be in the low end of the Toolkit default input factor range, that is, around or even below 1g/t waste.

Sheila Logan, Programme Officer,
Secretariat of the Minamata Convention on Mercury,
UN Environment Programme,
International Environment House 1, Geneva, Switzerland

While this work is still in progress, and additional data is needed from other parts of the developing world, it should be safe to say with some certainty that the mercury emission estimates from open waste burning based on the Toolkit may in some cases be overestimated. In some recent cases, where UNITAR has assisted countries' inventory efforts on The Toolkit's Inventory Level 2 (where estimation factors can be adjusted to local conditions), the input factors have been adjusted accordingly to 1 g/t waste).

Another massive uncertainty in this calculation is the amount of municipal waste burned nationally and globally. Nationally, authoritative data on this issue are not available, as open waste burning is mostly informal, and never registered in detail. Estimates have in some case been developed for waste management planning, for uPOP inventories (under the Stockholm Convention work), or for climate emissions inventories under the Kyoto Protocol.

To illustrate the order of magnitude of mercury emissions from open waste burning however, it may be useful to look at a global study on emission of trace gasses (etc.) from open waste burning conducted by Wiedinmeyr et al. (2014). The study applies available national or regional experience estimates on amounts of municipal waste produced per capita in combination with municipal waste collection rates, and a set of assumptions developed by the IPCC (2006) for greenhouse gas emission inventories. Thereby they reach an estimate for global amounts of municipal waste burned informally plus waste burned in controlled landfills (where fires can happen spontaneously from ignition of landfill gas, or be initiated on purpose to reduce waste amounts). Wiedinmeyr et al. (2014) combines this waste amount with an emission factor of 0.208 (+/-0.13) g Hg/t waste from one study in (Chen et al. 2013), and reach a resulting estimate for mercury emissions from open waste burning of 204Kg Hg/y.

It is worth noting the major uncertainties in the study by Wiedinmeyr et al. (2014):

- The estimates used for municipal waste generation are uncertain, and in many cases aged, indicating that they could potentially underestimate the waste amounts generated.
- The study applies an assumption (from the IPCC manual) that 100% of the waste in rural areas is burned informally and that 100% of the un-collected waste in urban areas is burned informally, and in addition to this comes burning of collected waste in landfills/dumps. While the fraction of uncollected waste being burned is no doubt high in many developing countries, this may likely be an overestimation.
- The emission factor used (from China, Chen et al. 2013) is in fact an emission factor from a modern technical waste incineration facility with air pollution control filters, and the relevance of the factor for open waste burning can thus be questioned.

Our (very) preliminary estimate of average mercury concentration in municipal waste in developing countries, where open burning is most prevalent, is in the range of 0.6-1.9 g Hg/t waste, where the low end is closer to current developed countries levels (to be further worked on). Now, currently no studies have been identified on what fraction of mercury is emitted to the atmosphere per tonne of waste burned openly. Mercury's boiling temperature is 356.7 degrees Celsius, and emissions will even start happing below that temperature (as the vapour pressure increased with increased temperature even below the boiling point). If it is assumed, as seems reasonable, that 356.7 degrees Celsius can easily be reached in open waste burning, it seems likely that most of the mercury may be emitted when municipal waste is burned openly. This is also the assumption in the Toolkit, where – for simplicity, given the lack of precise data – 100% of the mercury present is considered as emitted from open waste burning.

As a very preliminary conclusion, based on the considerations above, in combination with knowledge of the estimated mercury demand over the years, the total emission could very well be larger than

estimated by Wiedinmeyr et al. (and the draft GMA 2018), possibly in the range of some 200-600 Hg/y, including mercury from trace concentrations in other materials than mercury-added products (the estimate can be refined further based on existing data). Even ion case the actual emissions from open waste burning are be in the low end of this interval, the numbers underline that this is indeed a significant mercury emission source in the global perspective that is worth investigating in more detail with a view to inform considerations on including reduction of open waste burning in the Minamata Convention.

We hope that you may find the provided information of relevance, and we remain available, should the Secretariat wish to involve UNITAR in the further investigations of this issue.

With the best wishes,

Jakob Maag
Senior Specialist

Chemicals and Waste Management Programme Unit
Division for Planet

United Nations Institute for Training and Research (UNITAR)
Palais des Nations, CH-1211 Geneva 10, Switzerland
Mobile: +45 2428 6449
Direct: +45 7575 7565
Back-up: +41 (0)22 917 8392 | Email: Jakob.MAAG@unitar.org / CWM@unitar.org
Website: www.unitar.org | www.learnatunitar.org | www.unitar.org/event

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4. Information submitted by the International POPs Elimination Network (IPEN)

28/06/2018

IPEN combined submission to the Minamata Convention secretariat on;

- **mercury emissions resulting from the open burning of waste.**
- **capacity-building and technical assistance and technology transfer,**

Lee Bell
Mercury Policy Officer
IPEN
leebell@ipen.org

Mercury emissions from the open burning of waste.

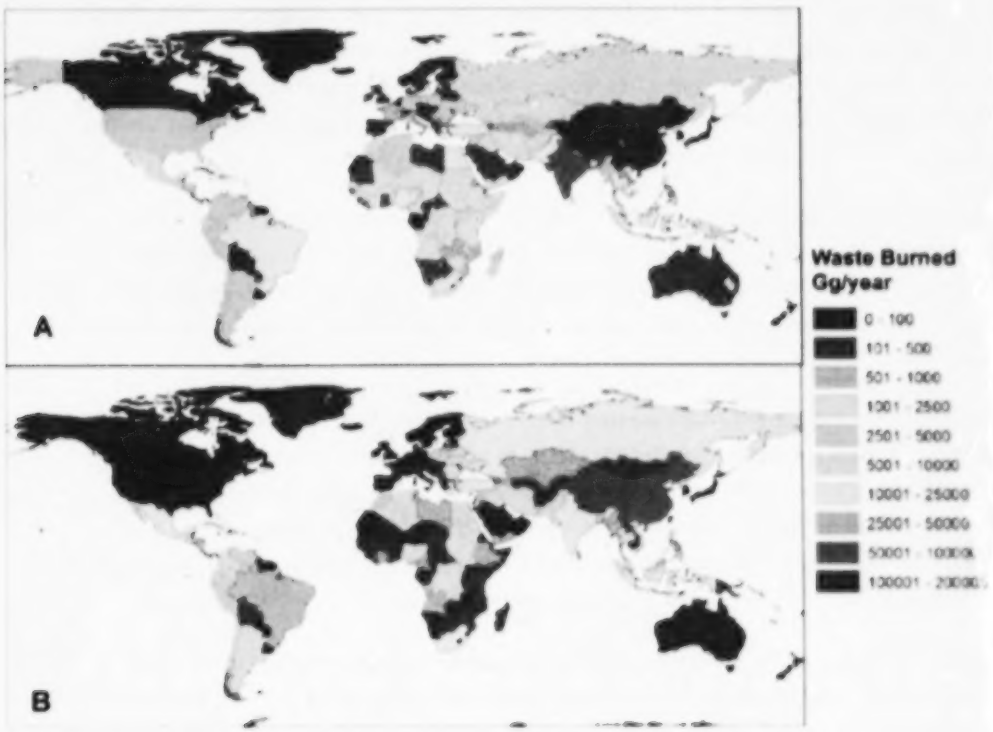
In many developing countries (and in some developed countries) the practice of open burning of waste is practiced for a range of reasons including;

- volume reduction in the absence of a waste management/collection system;
- sanitation in the absence of a waste management/collection system;
- recovery of valuable metals from some waste streams (such as e-waste);
- mixed waste is too contaminated to recycle
- spontaneous or deliberately lit landfill fires.

This submission comments on the potential for capacity building and technology transfer to dramatically reduce the prevalence of open burning and the mercury emissions that result from it. Technology and capacity building should be extended beyond a narrow mercury focus to establish programmes that establish basic waste collection and separation systems that have an emphasis on separating organic and hazardous waste (highlighting mercury waste streams) from the recyclable waste stream. Synergies with funding, capacity building and technology transfer mechanisms of other chemical conventions should be explored as open burning is also a significant contributor of UPOPs such as PCDD/DF (Wiedinmyer et al 2014) and could be addressed in joint waste management projects based around collection and source separation to allow for recycling and treatment of discreet waste streams. Without basic source separation and collection systems mercury waste will continue to be a major contributor to anthropogenic mercury emissions from open burning.

Mercury can be liberated as vapor phase and particulate bound emissions from open burning waste fires leading to air, soil and water contamination as well as human health impacts. Waste containing mercury such as e-waste, medical waste and consumer products (CFLs, cosmetics,

switches, thermometers) contribute to these emissions. It has been estimated that open burning of waste may contribute up to 10% of current anthropogenic emissions of mercury (Wiedinmyer et al 2014). A significant amount of open burning is situated in South Asia, south east Asia, Latin America and to a lesser extent, Africa (see fig 1). Open waste burning is also conducted in Pacific Islands.



Total estimated annual waste burned (Gg yr^{-1}) at the residential level (A) and at dumps (B).

Fig 1 Open burning estimates for residential and landfill mass. (source Wiedinmyer et al 2014)

A key response to open burning of waste which is leading to mercury emissions is the need to implement decentralised, economical waste management systems that maximise reuse and recycling of materials, separate hazardous materials for recycling or disposal and which directs organic wastes to value added processes while creating local employment opportunities.

Capacity building programmes for developing countries and countries with EIT to develop basic waste management systems based on collection and separation of material types is essential. Aid programmes often prioritise the construction of landfills and waste incinerators which sit at the bottom of the waste management hierarchy and are the least sustainable waste management and resource recovery options. They lead to ongoing groundwater contamination, UPOPs release and destruction of resources. Waste incineration is often proposed as a 'solution' to landfill and even as a better alternative to open burning as incineration allegedly takes place in 'controlled conditions'. However, the production of thousands of tonnes of toxic ash from

incinerators requires additional landfill so the landfill problem is not in any sense 'solved'. Mercury waste management experts also contend that waste incineration is not appropriate for mercury contaminated or containing wastes as the risk of release of mercury vapors is high (Merly and Hube, 2014).

Fortunately, mercury waste is amenable to recovery despite its hazardous nature. If capacity building programmes can be directed at development of locally relevant, basic waste collection and sorting systems then hazardous components of the waste stream such as mercury bearing waste can be separated for treatment and recovery of mercury using technology that is readily available in developed countries and which is a fraction of the expense of establishing landfills or incinerators.

These technologies include fluorescent lamp and other mercury bearing lighting recycling, continuous distillation processes for mercury contaminated soils, mining wastes and sludges from the petrochemical and gas industries. Distillation technologies are already employed in the oil and gas sector to remove mercury from produced gas to protect gas storage systems from corrosion.

Technology transfer and capacity building that addresses the whole of the waste system in developing countries is important. The waste sector should be seen through the lens of the emerging circular economy and sustainable development goals. Instead of perceiving waste as a problem to be buried or burned it should be an opportunity to build small sustainable businesses in impoverished communities, generate local scale clean energy and employment while protecting human health and the environment.

Attention should be given to non-combustion waste management alternatives in terms of technology transfer. Waste management policy in the EU is moving away from incineration of waste and subsidies are being withdrawn in recognition that incineration is not compatible with the circular economy. Developing countries should be given the opportunity to 'leap-frog' polluting incineration and burial technology in the waste management sector and adopt cutting edge techniques to manage their waste through the capacity building and technology transfer processes.

A key aspect of this sustainable waste management process is source separation of organics. Organic waste is the main contributor to anaerobic conditions in landfill, leaching metals under reductive conditions into the groundwater and releasing large volumes of methane- a potent GHG. Organic waste also poses problems for incineration due to its high moisture content requiring supplemental fuel application (usually gas or oil) to reduce moisture levels. This leads to further emissions. Far more productive is the separation of organic materials from the waste stream and their use in anaerobic digestion (AD) and/or composting. The development of biogas from AD can be utilised for energy generation without the release of UPOPs and ash, a major problem suffered by waste incineration. The AD systems can be scaled up from basic household models through to school, commercial and fully industrialised models. Biogas from AD can also

be used for cooking displacing more polluting cooking fuels. The final solid residue, digestate, is a valuable fertiliser for agricultural communities. There are clearly opportunities for technology transfer and capacity building programmes to address the waste systems of developing countries more holistically and the instruments of the Minamata Convention dedicated to these purposes (such as the Specific Trust Fund) could be applied. There is a clearly a need to use such mechanisms to address the uptake of AD in developing countries. Sub-Saharan Africa being a case in point where biogas could have enormous positive impacts but lacks seed funding and institutional understanding (Mwirigi et al 2014).

Once organics are removed from the waste stream other benefits are apparent. Organic wastes contaminate recycling in mixed waste systems. Their removal at the source separation stage increases the value of the recyclable component of the MSW stream which remains clean. Mixed waste and recyclables contaminated with organic materials has low value and is at higher risk of open burning. One sector of the recyclable components includes mercury impacts wastes.

A key source of mercury waste in municipal waste generation is compact fluorescent lighting (CFL) and associated fluorescent tubes. Once added to burning waste and broken the mercury phosphor powder escapes the glass lamp and can cause significant contamination and human exposure in vapor phase and as particulate.

Small-scale recycling facilities can be developed for CFL and tubes which contain the mercury-based powder, while separating glass, metal and plastic components for recycling. Many spent lamp recycling collection systems are being established at point of sale to allow customers to return burned out lamps intact. These collected lamps can then be consolidated and sent to regional recycling facilities.

Figure 2. Fluorescent lamp recycling unit

These semi-automated units can recycle between 1 and 10 million lamps per year, are fitted with carbon filters and claim to limit mercury emissions to 0.001-0.002 mg/m^3. The outputs are separated mercury bearing phosphor power, glass cullet, and metal or plastic end caps.

Figure 3. CFL recycling unit fitted in Surabaya Indonesia 2013 and glass cullet from the process.

Locations that lack waste collection infrastructure may benefit from point of sale collection systems where clusters of recycling collection can take place for other hazardous and problematic wastes such as batteries and plastic. This helps to streamline the collection systems for the end recycling operation and is more convenient for the consumer resulting in higher collection rates.

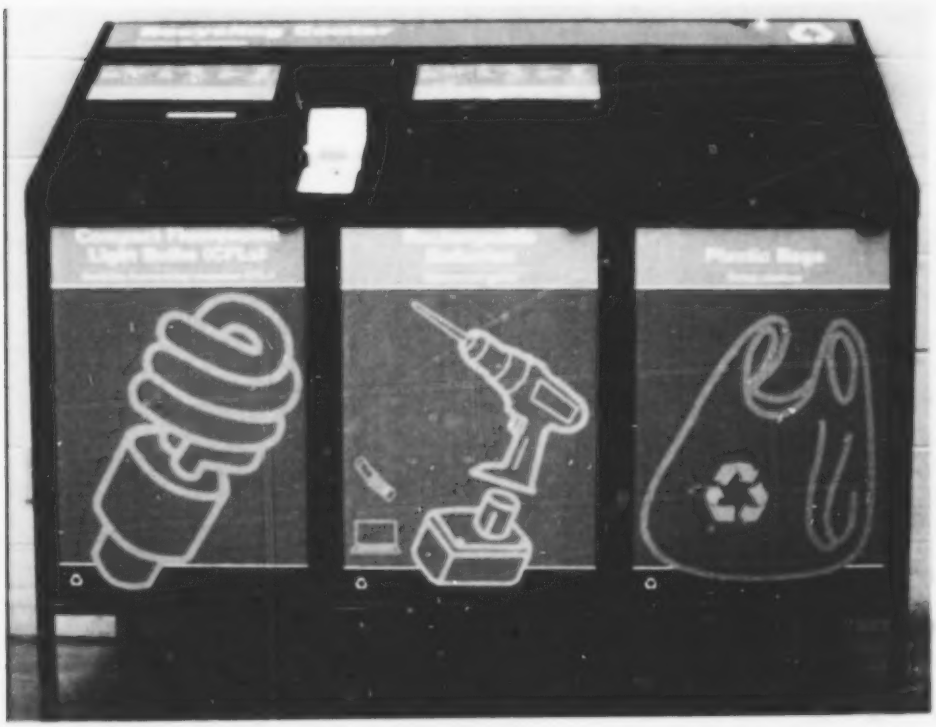


Figure 4. Collection points for fluorescent lamps using mercury can also be combined with collection points for other problematic wastes such as batteries and plastics.

as they may require significant volumes to remain profitable. National governments can consider extended producer responsibility schemes to help fund the establishment of these recycling operations. Poor disposal of CFL and mercury tube lamps is widespread in developing countries (Ecowaste Coalition, 2018) as represents a sector where successful recycling could be implemented economically based on commercialised technology.

Medical, dental, commercial, mining, oil/gas and industrial mercury waste.

These sources of mercury waste may also be included in open burning practices where waste collection infrastructure is absent. Technologies to extract mercury from these wastes and preventing them from entering the environment are readily available. Capacity building and technology transfer could see the implementation of regional, national and state mercury recovery centres in developing countries to manage these sources of mercury pollution.

Dental amalgam separators fitted in dental clinics where mercury amalgam is used can play a role in reducing mercury in the waste stream. However, eliminating mercury from dental therapy is a far more efficient solution which is clinically and economically feasible on a global scale. Many countries no longer use dental amalgam and the alternatives are well established and cost effective. However, for those dental practices that persist in using mercury separators are a significant barrier to environmental releases assuming that the waste they collect is managed in an environmentally sound manner. Mercury waste from dental amalgam separators can be processed for mercury recovery in the same way as industrial mercury waste through distillation and recovery methods.

Figure 5. Dental amalgam waste separator

Continuous distillation processes from recovering mercury from commercial, mining, oil/gas and industrial mercury waste are well established. However, under the article 11 of the Minamata Convention recovered mercury can still be marketed as a commodity for uses allowed under the convention. For uses where the mass balance of mercury inputs and waste can be potentially be contained by recovery technologies (e.g. CFL recycling) this may not present a large problem. However, if mercury recovery technology becomes widespread in developing countries the supply of this form of mercury could dramatically increase global supply. This is especially true of the mining and gas sectors where large volumes of mercury can be recovered from production gas and tailings.

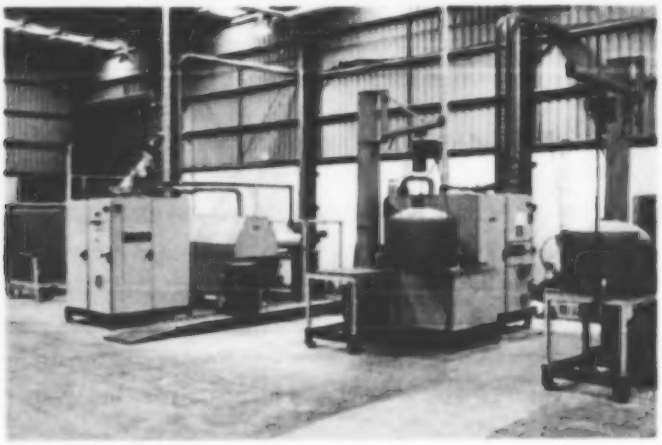


Figure 6. Continuous Flow Distillation plant for mercury extraction from waste

Careful thought need to be given to control mechanisms to restrict the supply of recovered mercury to the global market to prevent a proliferation of mercury supply. At the same time any restriction of sales of mercury by those operators of recovery systems may undermine the viability of their operation. It is clear that if mercury produced through recovery operations is to be 'retired' from the commodity market then consideration needs to be given to purchasing mercury for retirement from recovery operations. A key consideration will be who should pay for mercury to be retired? For the mining, petroleum and gas sector there are clearly opportunities to implement polluter pays systems. For products containing mercury, the costs of retirement could be directed to manufacturers who choose to use mercury in production and processes. In any event if the twin policy aspirations or mercury recovery and permanent mercury retirement are to be achieved, then this issue will need to be resolved.

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